AVIATION WEEK

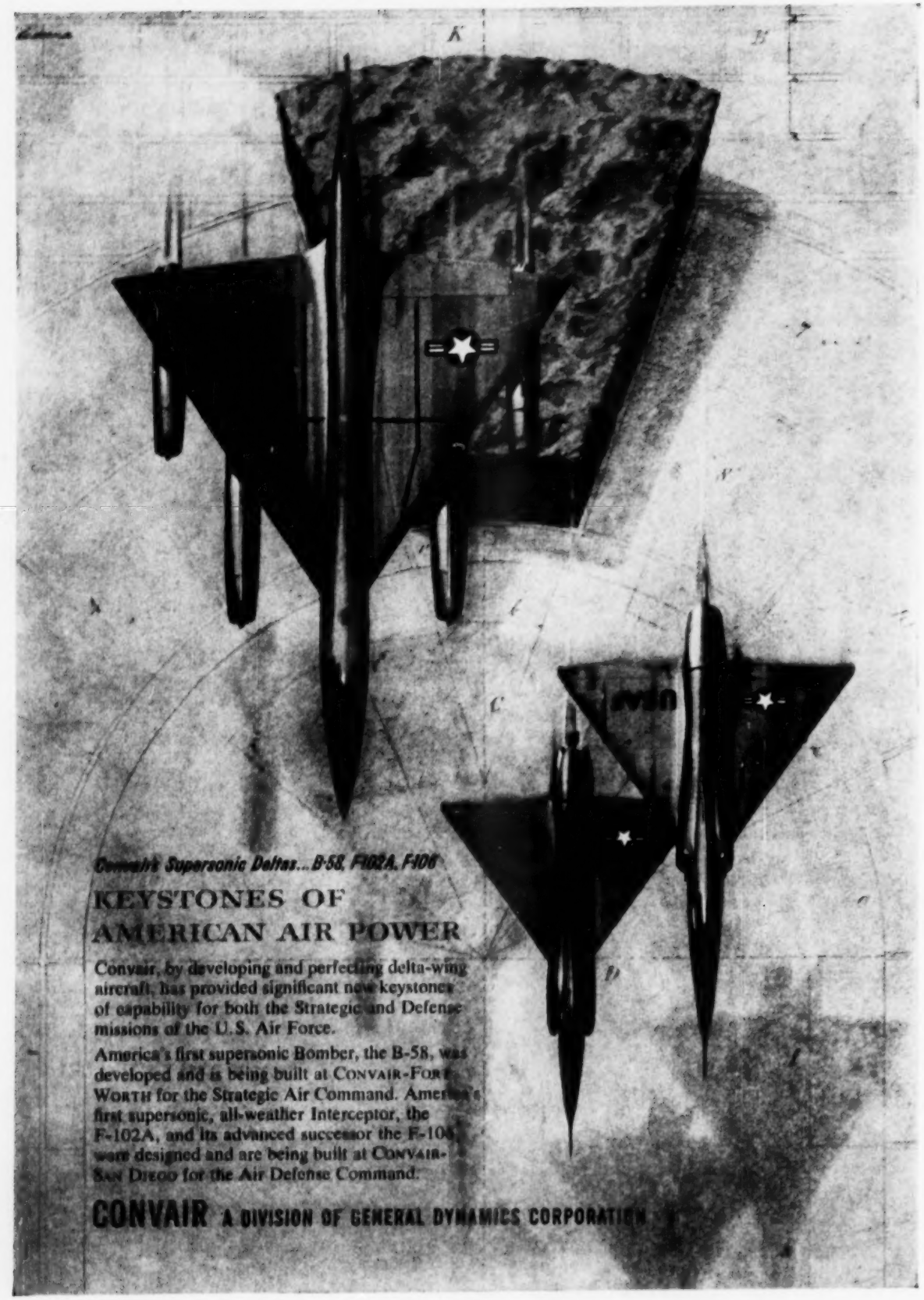
A McGRAW-HILL PUBLICATION

December 16, 1957 75 cents

Next Space Steps:

- Getting Man Back
- Man's Flight Role

Dassault Etendard VI



Convair Supersonic Deltas... B-58, F-102A, F-106

KEYSTONES OF AMERICAN AIR POWER

Convair, by developing and perfecting delta-wing aircraft, has provided significant new keystones of capability for both the Strategic and Defense missions of the U.S. Air Force.

America's first supersonic Bomber, the B-58, was developed and is being built at CONVAIR-FORT WORTH for the Strategic Air Command. America's first supersonic, all-weather Interceptor, the F-102A, and its advanced successor the F-106, were designed and are being built at CONVAIR-SAN DIEGO for the Air Defense Command.

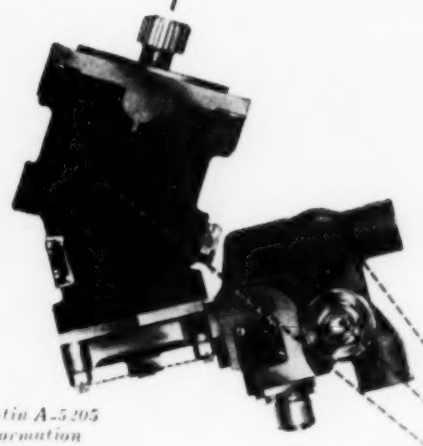
CONVAIR A DIVISION OF GENERAL DYNAMICS CORPORATION

VICKERS helps scan new horizons . . .

by turning 3 tons with 13 pounds

The giant "saucer", rotating atop this Lockheed Super Constellation, contains an airborne radar antenna. It requires a high-power-to-weight ratio driving mechanism for the scanning operation. This mechanism must be compact, dependable, able to provide constant speed, regardless of load change . . . and operate in a position remote from the aircraft power supply.

The small (approximately 13 pounds) VICKERS PACKAGE DRIVE more than meets the drive requirements of the large (30 feet diameter) radome. And — like similar Vickers hydraulic components used in the Constellation for other purposes — provides proven dependability spanning many years of aircraft applications.



Drive components include:

- Modulating flow control valve maintains selected constant speed, regardless of load change.
- Slide valve for selection of motor rotation direction and speed.
- Fixed displacement hydraulic motor for driving the radome.

Write for Bulletin A-5205 for further information about the motor.

VICKERS INCORPORATED

DIVISION OF SPERRY RAND CORPORATION

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7799 OVERSEAS REPRESENTATIVE: The Sperry Gyroscope Co., Ltd.—Great West Road, Brentford, Middx., England

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YOU NAME THE CASTING. Dow can supply you with ordinary and extraordinary shapes or sizes. Specialized techniques rigidly maintain your standards and specifications. Heavy-wall or thin-wall, room or elevated temperature use, the best—and surest—answer to your problems is Dow magnesium castings! Contact your nearest Dow sales office for additional information. THE DOW CHEMICAL COMPANY, Foundry Sales, Bay City, Michigan.

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AVIATION CALENDAR

Dec. 16-17—Missouri Conference on Utilization of Engineers and Scientists, University of Missouri Campus, Columbia, Mo.

Dec. 16-18—Air Traffic Control Symposium, "The Mission and Methods of the Airways Modernization Board," sponsored by Franklin Institute, Sheraton Hotel, Philadelphia, Pa.

Dec. 17—21st Wright Brothers Lecture—Hypersonic Flight and the Re-Entry Problem, H. Julian Allen, NACA, Natural History Building Auditorium, Smithsonian Institution, Washington, D. C.

Dec. 18—Gas Turbine Development, speaker: Rear Adm. S. B. Spangler, USN, Air Development & Material Center, at Engineers Club, Philadelphia, Pa.

Jan. 6-8—Fourth National Symposium, Electronics Reliability and Quality Control, Hotel Statler, Washington, D. C.

Jan. 9-10—Meeting of Airlines Proximity Warning Indicator & Air Collision Avoidance System Committee, Hollywood-Roosevelt Hotel, Los Angeles, Calif. Open to public only Jan. 9. Those wishing to make presentations must write to Air Transport Assn., Washington, D. C., by Dec. 20.

Jan. 13-17—1958 Annual Meeting, Society of Automotive Engineers, Sheraton-Cadillac and Hotel Statler, Detroit, Mich.

Jan. 13-May 14—Lecture series on Space Technology, sponsored by University of California and Ramo-Wooldridge Corp., to be held in Los Angeles, San Diego and San Francisco. For details write: University of California Extension, Dept. of Conferences and Special Activities, Los Angeles 24, Calif.

Jan. 14-15—Yankee Instrument Fair & Symposium, sponsored by Instrument Society of America (Boston, Connecticut Valley and Fairfield County Sections), Hotel Bradford, Boston, Mass.

Jan. 20—Winter Meeting, Provisional Western States Section, The Combustion Institute, California Institute of

(Continued on page 6)

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Vol. 67, No. 24

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The Many-Sided Career of Early Bird Robinson

Building this 30 h.p. plane in 1908 led to Robinson's meeting with Glenn Curtiss and a long association with this great aviation pioneer.

This early sport plane, designed and built in 1915 by Robinson, attained 81 m.p.h., weighed only 600 pounds.

Hugh Robinson (far left) at the launching of an early Curtiss hydroplane at San Diego in 1911. Glenn Curtiss, designer, is at far right.

Hugh Robinson's skill as a flyer was enough to win him lasting aviation fame; but when you add his abilities as a designer and builder of aircraft, you complete the picture of a many-talented man.

Robinson built a one-cylinder automobile in 1896, a dirigible in 1906 and a tractor-type monoplane in 1908. This airplane led to his meeting Glenn Curtiss. For many years afterward, Robinson helped Curtiss design, build and fly the early and famous Curtiss aircraft.

Robinson was a famous early-day exhibition flyer, making more than 900 appearances here and abroad. He was among the first to fly air mail, making a mail run between Minneapolis and Rock Island, Ill., in 1911. He demonstrated a pioneer dive bombing technique with grapefruit "bombs" in California; operated a flying school in France, and built a sport plane that weighed only 600 pounds.

Altogether, Robinson flew more than 3,000 hours in compiling a useful and enviable record as a daring and resourceful airman.

● A pioneer in research and development of aviation fuels, Phillips Petroleum Company is, today, a foremost supplier of high octane gasoline for commercial, private and military aircraft. In step with the future, Phillips is a leading producer of *super-performance* jet fuels for the latest designs in turbo-props and jets. And Phillips research continues to lead the way for development of fuels for the aircraft of tomorrow.

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Remotely adjustable without a Servo System

Shown actual size

SPECIFICATIONS

RANGE: Adjustable 0 to 15 psia (0 to 760mm Hg)

REPEATABILITY: ±1mm Hg.

ACCURACY: ±2mm Hg.

ACCELERATION: 50 g in any direction

VIBRATION: 25 g to 2000 cps.

WEIGHT: 14 oz.

TEMPERATURE RANGE: −65° to +160°F.

SWITCHING CURRENT: 1 ampere resistive load

Operates under severe environment from atmospheric pressure to vacuum with accuracy of 2mm Hg.

The Electroset Pressure Switch offers a new and easier way to calibrate and set a pressure switch from a remote position. The contacts are automatically adjusted simply by applying the desired switching pressure and momentarily energizing a solenoid. When the solenoid is de-energized, one contact is securely clamped while the other contact remains free to move with changes in pressure. Once set, the switch will open at pressures below the calibrating pressure and close at pressures equal to or above the calibrating pressure.

The Electroset Pressure Switch is vacuum sealed, isolated from dirt, moisture or corrosive fluids, including the fluids used to actuate it. It is ideally suited for industrial process control applications where an adjustable switch must be located in a remote or inaccessible location or where the switch must operate in an atmosphere which would degrade the performance of a non-hermetically sealed unit. Among military applications are arming of warheads and control of aircraft or missiles. Write for Technical Bulletin 1570 to Trans-Sonics, Inc., Dept. 7, Burlington, Massachusetts.

TRANS-SONICS

Precision Transducers

*TRADEMARK

AVIATION CALENDAR

(*Continued from page 4*)

Technology, Pasadena, Calif. For details write: Mr. G. S. Bahn, Marquardt Aircraft Co., Van Nuys, Calif.

Jan. 20-Feb. 7—Aviation Institute for Commercial Carriers and Business Pilots, Univ. of Southern California, Los Angeles.

Jan. 22-26—First International Air Show & Exposition, Master Field, Miami, Fla. For details write: P.O. Box 2829, Miami 17.

Jan. 29-31—Fourth Annual Meeting, American Astronautical Society, Main Auditorium, Engineering Societies Bldg., 29 W. 39 St., N. Y. C.

Jan. 30-31—American Society for Engineering Education, 1958 College-Industry Conference, U. of Michigan, Ann Arbor.

Jan. 30-31—Seventh Annual Instrument Short Course, sponsored by Southern California Meter Association and Los Angeles Harbor Junior College, at Los Angeles Harbor College, Wilmington, Calif.

Feb. 3-4—Industry-Service Symposium, Flight Control-Panel Integration, Biltmore Hotel, Dayton, Ohio. For details: Mr. J. H. Kearns, Box 942, Dayton.

Feb. 19—"Are Flying Saucers Fact or Fancy?", Dr. Hugh Winn, Missile and Ordnance Systems Department, GE., Engineers Club, 1317 Spruce St., Philadelphia, Pa.

Mar. 13-14—Second National Conference on Aviation Education, Hotel Mayflower, Washington, D. C.

Mar. 17-20—Joint Aviation Conference, American Rocket Society-American Society of Mechanical Engineers, Statler-Hilton Hotel, Dallas, Tex.

Mar. 17-21—1958 Nuclear Congress, managed by American Institute of Chemical Engineers, 25 W. 45 St. N. Y. C.

Mar. 18-19—First Interscience and Industry Symposium on Guided Missiles Training equipment (limited to those with Secret clearance) Naval Ordnance Laboratory, White Oak, Silver Spring, Md. For details write: Mr. J. G. Vaeth, Head of New Weapons & Systems Division, U. S. Naval Training Device Center, Port Washington, L. I., N. Y.

Mar. 24-29—Fourth International Instrument Show, Caxton Hall, London.

Mar. 30-Apr. 1—RFC/RNAS Reunion, (World War I), Toronto, Canada. Contact: C. B. Stenning, Chairman, 149 South Drive, Toronto 5.

Apr. 8-10—Eighth International Symposia, Electronic Waveguides, Microwave Research Institute of Polytechnic Institute of Brooklyn Engineering Societies Bldg., 29 W. 39 St., N. Y. C.

Apr. 14-18—Annual Technical Meeting, American Welding Society, Hotel Statler, St. Louis, Mo.

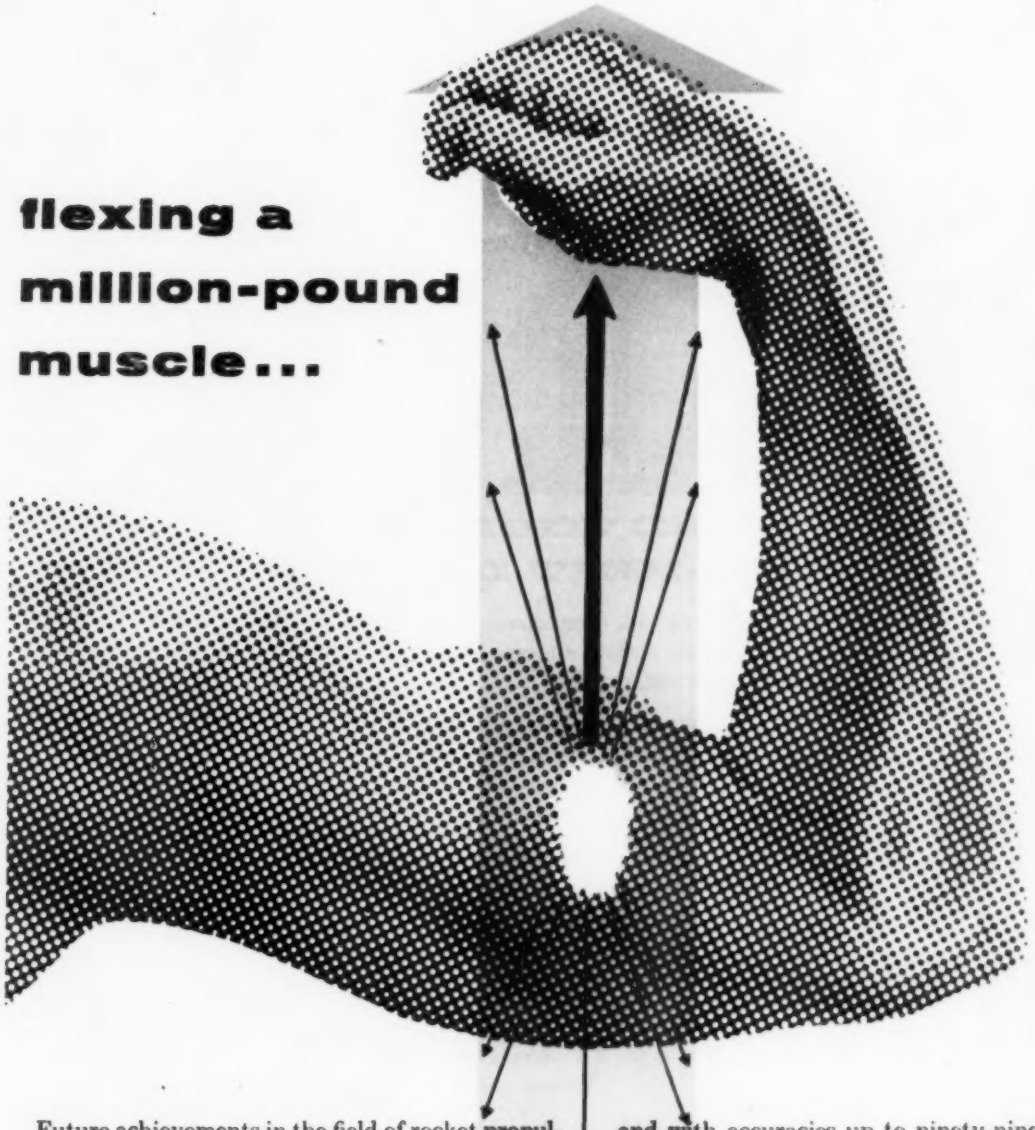
Apr. 16-19—14th Annual National Forum, American Helicopter Society, Sheraton Park Hotel, Washington, D. C.

Apr. 17-18—Institute of Environmental Engineers, Second Annual Technical Meeting, New Yorker Hotel, New York.

Apr. 22-24—1958 Electronic Components Conference, Ambassador Hotel, Los Angeles, Calif.

Sept. 1-7—1958 Flying Display and Exhibition, Society of British Aircraft Constructors, Farnborough, England.

flexing a million-pound muscle...



Future achievements in the field of rocket propulsion depend upon the ability to test prototype engines at rapidly increasing power levels. To keep pace with these higher power requirements, RMI is completing work on a giant rocket test stand.

The new RMI test structure is capable of testing rocket engines in the million-pound thrust class. Its massive rotating system provides firing attitudes from vertically downward to 45 degrees above horizontal. The control center contains a maze of instruments that continuously record separate events occurring, within the engine, at intervals ranging from one-tenth of a second to less than one millisecond . . . and with accuracies up to ninety-nine per cent.

This addition to RMI's already-extensive test facilities paves the way for tomorrow's more powerful and more efficient rocket powerplants. It's another example of how RMI — America's *first* rocket family — is continuing to pioneer in the development and production of new engines for supersonic manned aircraft . . . helicopters, catapults and test sleds . . . and missiles for defense and space exploration.

Engineers, Scientists — Perhaps there's a place for *your* talents in RMI's expanding organization. Our new projects present challenging problems and the chance for greater responsibility.

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The M1 Toss Bomb Computer System is standard equipment on the Air Force's operational fighter-bombers. It enables attack on "targets of opportunity" and – of all fighter-bomber systems – it provides superior accuracy and a flight pattern least vulnerable to counter measures. Its design and configuration allow installation in any known fighter or bomber.

Researched, designed and mass produced by Mergenthaler Systems Engineering Division, this compact and efficient device is just one example of Mergenthaler's outstanding work on complex integrated systems, support equipment and special components.

This accumulated experience in systems engineering, together with Mergenthaler's extensive manufacturing facilities in both the United States and NATO countries, is of very real importance to the nation's defense projects . . . Mergenthaler Linotype Company, 29 Ryerson Street, Brooklyn 5, New York.

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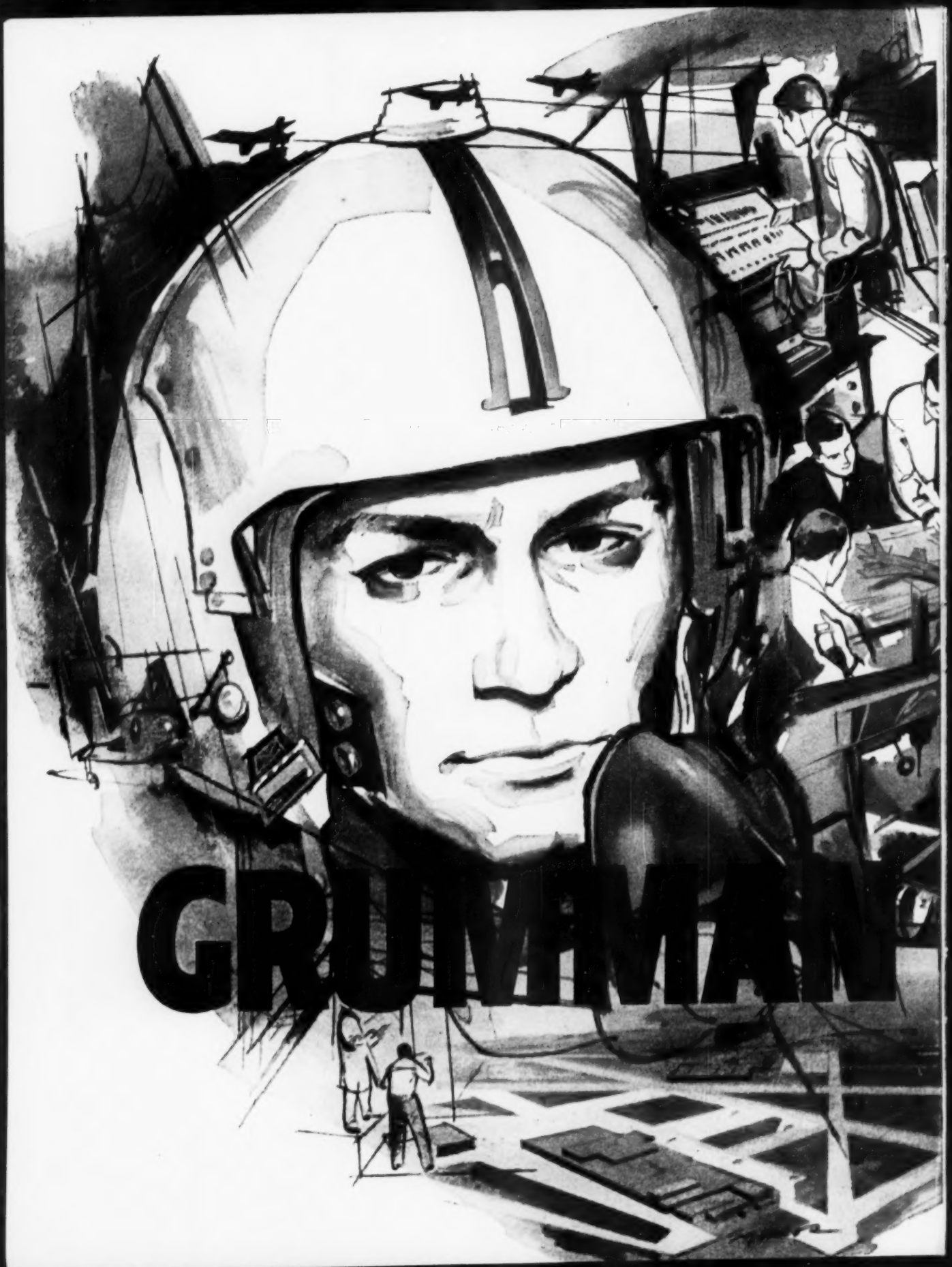
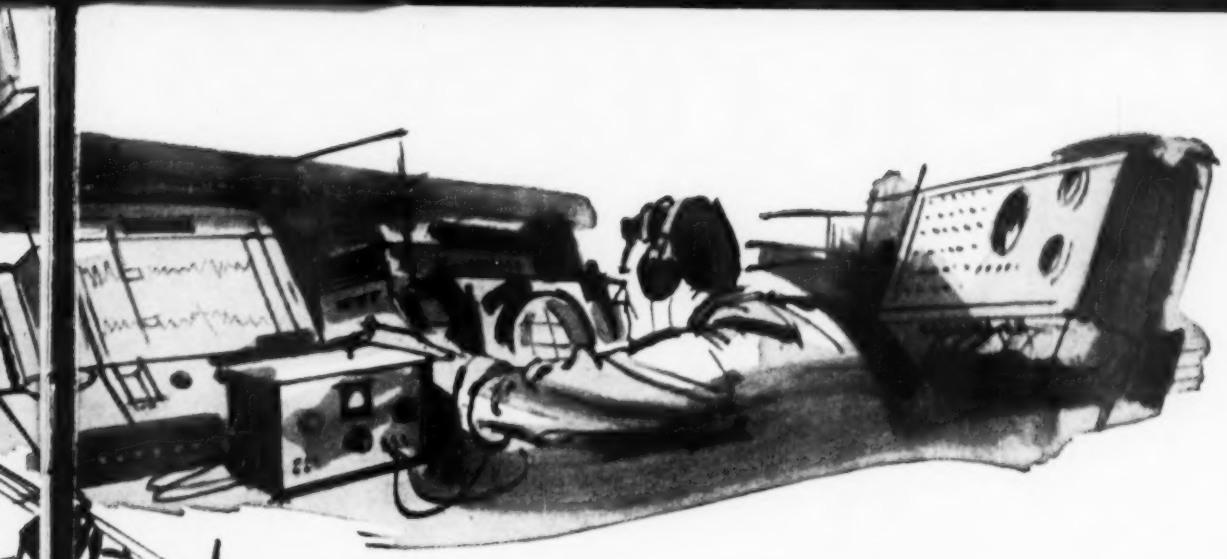

GRUMMAN



Some facilities are easily measured. Like floor space. Grumman has 3,400,000 square feet of it, all in use. And the runways at Bethpage and Peconic River, Long Island, N. Y., and at Stuart, Fla. They stretch a total of 9 miles.

You can size up other Grumman facilities, too. Like design rooms. Wind tunnels. Analog computers. Altitude chambers. Test-flight simulators. Techniques in forming, machining and welding. Quality control practices. Oscillographs. Research with cermets. Or the process that mills metal chemically.

You can see the scope of Grumman facilities other places. At the instrumented jet engine test stands. On the assembly line. In the air where missiles and other armaments are test-fired. Or at the sixty places around the world where Grumman field service is available 24 hours a day.

Anything else? Yes, Grumman's most important facility: Its people. How do you measure them? Look at any Grumman plane. The amphibious SA-16 Albatross of air rescue fame. The S2F-1 Tracker, world's first anti-submarine aircraft capable of performing the complete search-attack assignment. The radomed WF-2 Tracer "early warning" aircraft. The F9F-8T, the Navy's only transonic fighter-trainer. Or the supersonic F11F-1 Tiger, the first fighter to incorporate into its design the area-rule (coke bottle) fuselage. That's the measure of Grumman people. And has been for 27 years in the production of over 24,000 planes.

FACILITIES

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A-7137

CRYOGENIC PUMP IS NOTEWORTHY NEW INDUSTRY DEVELOPMENT

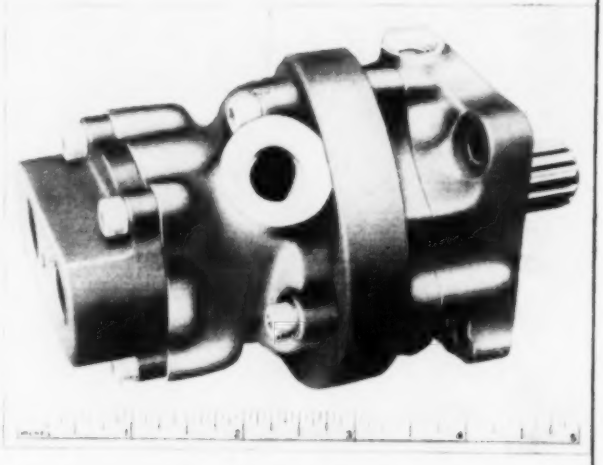
A product of Sundstrand-Denver, it has a demonstrated capcbility of pumping liquid nitrogen at pressures over 3000 psi at speeds of over 3500 RPM.

Piston type, extremely compact and lightweight, it has been under experimental development for a year and is suitable for pumping liquid gases such as nitrogen and oxygen. Sustained operating periods have been obtained repeatedly without any form of lubrication.

The pump is a design modification of a Sundstrand hydraulic motor which is made in many sizes and thus other larger capacity pumps can be provided with relatively little development.

The pump shown here has nine axial pistons and is of fixed displacement type. Metal parts have been selected to be compatible with liquid nitrogen. Minor material changes can be incorporated for satisfactory operation with the use of liquid oxygen.

The result of precision engineering and careful testing, these pumps appear to be the solution to many of the high power-to-weight problems encountered with missiles, rockets and high performance fighter planes; and, will prove highly useful for aircraft cooling systems and ground support equipment. Variation in orientation, size, mounting and assembly of these self-contained units can be supplied to suit your individual needs. For further information on using these pumps to solve your cryogenic pumping problems contact: APPLICATION ENGINEERING DEPARTMENT



PERFORMANCE DATA
SUNDSTRAND-DENVER CRYOGENIC PUMP

Displacement	0.130 cu. in./rev.
Capacity @ 3500 RPM	1.75 gpm
Horsepower @ 3500 RPM	3.8 HP
Volumetric Efficiency @ 3000 PSI	90%
Weight	2.5 lbs.
AND Mounting Flange	10260 Type X
Dwg. No.	ED699

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Another LINEAR first . . . a new, low compression-set Butyl Compound for use in "O" Rings. LINEAR Butyl Compound 7806-70 is a seal material that withstands compression set at elevated temperatures without being permanently deformed or losing its resiliency and its value as a seal. Also, Butyl withstands the chemical actions of the non-flammable phosphate esters such as "Skydrol", "Pydraul", "Celluflex" and "Lindol".

YET, PROVEN

Exhaustive tests, under method "B" of the ASTM, show this new LINEAR compound develops only 30 to 40% compression set after 70 hours at 212°F, as compared to the usual 70 to 95% set experienced with previous Butyl compounds. This unusually good resistance to permanent deformation, combined with a tensile strength of 2000 psi and an elongation factor of 275%, make this material an outstanding one for all "O" Ring applications and other molded shapes where Butyl rubber's excellent qualities are desirable.

Whenever you have a seal problem that is tough to handle—look to LINEAR for an answer. Write, or ask the local representative for complete information on LINEAR's new Butyl Compound 7806-70—today.

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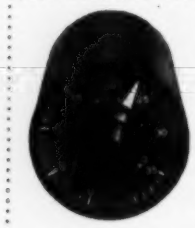
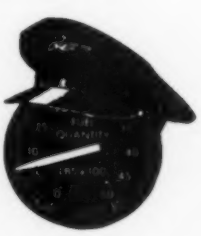
OVER 125 AIRCRAFT TYPES NOW FLYING SIMMONDS FUEL GAGE SYSTEMS



Now standard equipment on the Caravelle and Viscount for leading world airlines, Simmonds PACITRON Fuel Gage Systems furnish dependable, accurate fuel measurement and fuel management on every flight. PACITRON *load limit control* provides automatic control of fuel taken aboard in accordance with particular flight plan requirements.

In addition to load limit control, PACITRON offers these fuel management functions: level switching, totalization, telemetering for remote readings, and center of gravity control.

Currently flying on more than 50 famous airlines, PACITRON demonstrates Simmonds continued leadership as "first in electronic fuel gaging."



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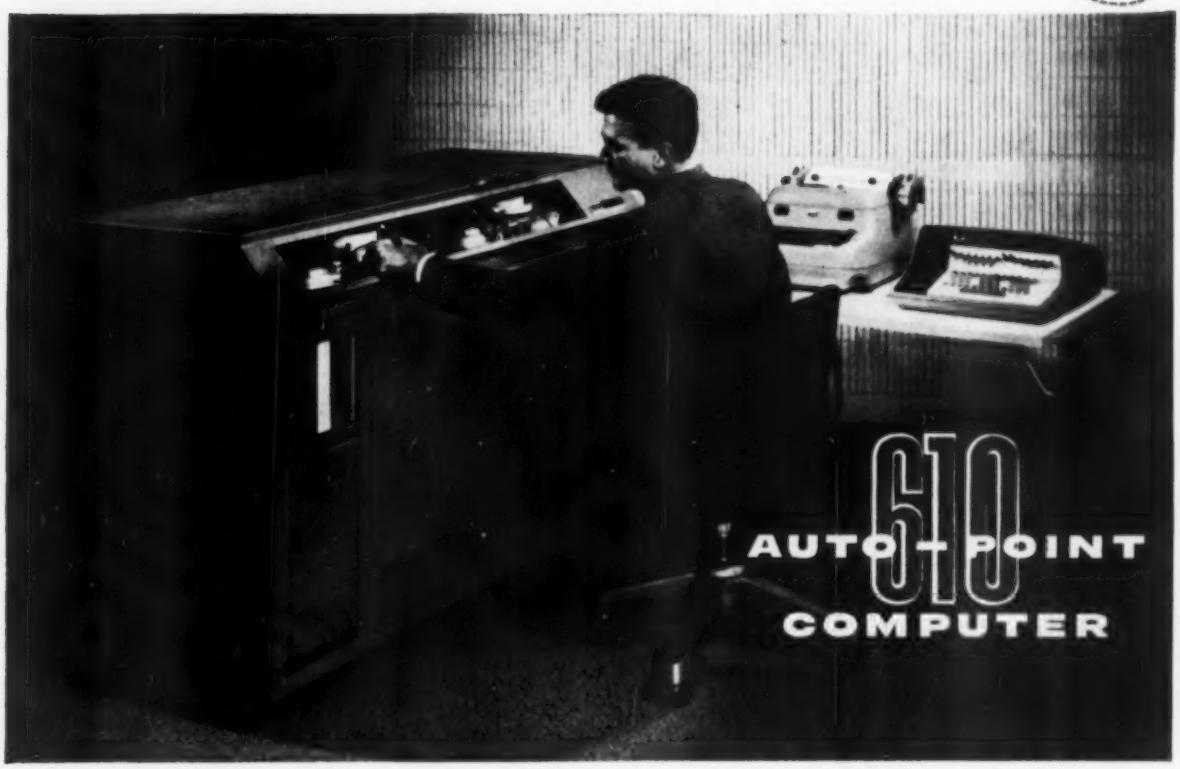
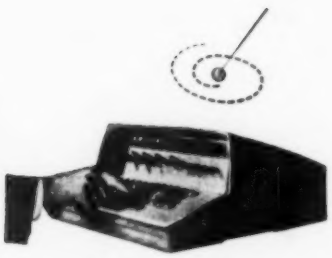
NEW LOW-COST COMPUTER WITH ADVANCED COMPUTING TECHNIQUES



The only desk-side electronic computer with direct programming and automatic positioning of decimal point



A few applications of the 610 Auto-Point Computer

Flutter Analysis

•

Performance Evaluations

•

Stress and Strain Calculations

•

Data Reduction

Two *exclusive* features of the new IBM 610 Auto-Point Computer help make your engineering time more completely creative. First, direct programming: computation takes place as the program *is being written*, eliminating the need for separate program test runs. Second, automatic positioning of decimal point: the engineer is relieved of the burden of planning movement of the decimal point, greatly reducing problem-solution time.

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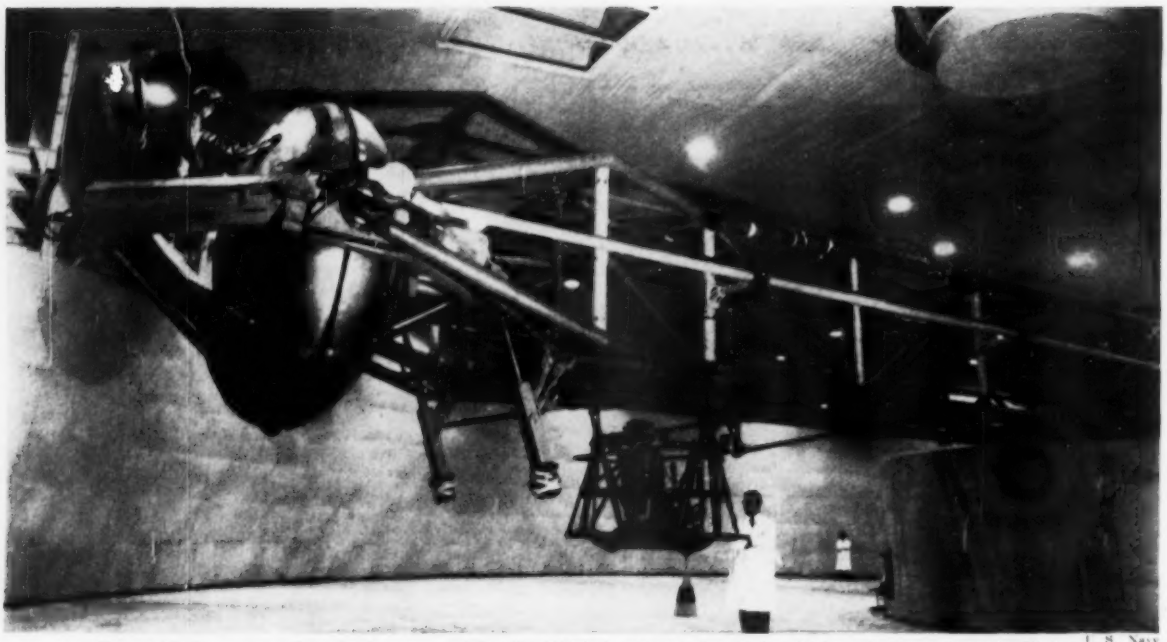

The world's largest centrifuge for humans, at Johnsville NADC, is capable of producing 40 times the force of gravity. Flight surgeons and engineers can ride within the "cockpit" at the end of a 50 foot arm. U. S. Navy Photo

JOHNSVILLE NAVAL AIR DEVELOPMENT CENTER STREAMLINES RESEARCH VITAL TO DEFENSE

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The NADC Aeronautical Instruments Laboratory at Johnsville is engaged in development and evaluation for the Army-Navy Instrumentation Program, and was first to develop the automatic artificial stability control for rotary wing aircraft. Other NADC projects include high-speed low-level cameras . . . techniques for underwater launching of guided missiles . . . and radio controlled drone planes carrying bombs, used so effectively against the enemy in Korea.

This defense center covers over 750 acres, including a Naval Air Station which provides aircraft for scientists carrying out their experimental missions. There are eight laboratory groups at Johnsville, specializing in computation; aircraft armament; systems for drones, missiles and other special aircraft; aviation medicine; air warfare research; aeronautical instrumentation; aero electronics; and experimental photography, a field unto itself.

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This is one of a series of ads on the technical activities of the Department of Defense

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USAF Forms Astronautics Directorate 26
► New unit to monitor space plans, missile defense; may conflict with McElroy's single manager.

Midway Traffic Jams Clog Entire System 38
► Chicago's overburdened Midway fights volume that exceeds capacity; customers shy away from O'Hare.

Sphere, Glider Feasible for Re-Entry 50
► Decision on which one to use, or to use both, may be key to winning second round in conquest of space.

MISSILE ENGINEERING

USAF Forms Astronautics Directorate 26
Sphere, Glider for Re-Entry 50
New Moon Proposal 26
Seek Cause of Satellite Failure 28
Soviet Predicts Failure 30
Regulus II, Polaris Program 31
New Thor Pictures 32
Russians Detail Future Sputniks 32
Free Enterprise Satellite? 32
Free Radical Challenges 55
Scientists Disagree on Space Role 61

AERONAUTICAL ENGINEERING

Speed Try Disqualified 37
MiG-21 Faceplate Fighter 67
T53, T58 Test Performance 69
Japan's First Home-Built Jet 78
Curtiss-Wright Cuts Staff 79
Boeing Flight Tests Silencers 79
F-107A Design Details 80

AVIONICS

1,400C Transistor Possible 97
Meteors Produce Ionosphere 102
Computer Navigates, Intercepts 105
Expansions, Changes 109
New Avionic Products 113

BUSINESS FLYING

Bell Plans to Widen Copter Market 121

AIR TRANSPORT

Midway Traffic Jams System 38
Deferred Freight Rates Proposed 45
Slick Asks to Suspend Some Service 45
Fare Denial May Mean Subsidy 40
NYA Wants Vertol H-44Bs 40
Electra Makes First Flight 41
Austin Accepts Northeast Presidency 41
Hong Kong Improves Airport 43
Airline Traffic Table 48
Airline Observer 49
Shortlines 49

EQUIPMENT

F-84F Tests Arrester System 34
Manipulators Serve Nuclear Units 83
Engine Cleaning Facility 87
Convair 880's Air Regulator 93
Container Saves Cargo Space 93
What's New 95
New Aviation Products 116

MANAGEMENT

Germans Delay Aircraft Decision 27
NATO Favors G.91? 37
C-W Asked for $5.5 Million Rent 37
Who's Where 23
Industry Observer 23
Washington Roundup 25

Calendar 4
Letters 136

EDITORIAL

Vanguard's Real Success 21

COVER: Dassault Etendard VI, one of the five entrants in the NATO lightweight fighter competition (see page 37), was designed to the NATO requirements. Powered by the Bristol Orpheus 3 turbojets, the Etendard VI is 39.5 ft. long and has a 26.9 ft. span. Production version would be powered by the Orpheus 12 rated at 6,800 lb. thrust without afterburner. Decision based on results of the competition (AW Oct. 28, p. 50) is expected in January.

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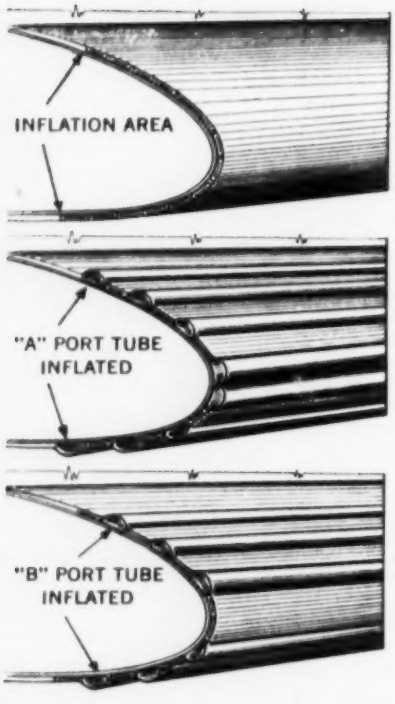

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EDITORIAL

Vanguard's Real Success

Now that the hubbub over the first unsuccessful test launching of the Project Vanguard test satellite has subsided, this project should be allowed to proceed at its pre-Sputnik leisurely pace. This country lost some 90 days ago the race in which Vanguard was our entry. Little international prestige can be re-couped from Vanguard's achievements even when its satellites are orbiting, although valuable scientific data can still be harvested from the program.

But there are two aspects of the Vanguard's initial test phase that outline important lessons for our future guidance. If these lessons are taken to heart, even Vanguard's failure could be an educational success.

First is the full and pitiless glare of publicity that has been focused on Vanguard since Sputnik I climbed into space. This spotlight generated its maximum illumination during the failure of the Vanguard launching at Cape Canaveral early in December. For the first time since the missile and satellite program began, the American public was fully informed within the limits of genuine military security what was actually happening on the Vanguard program.

Because the test was a failure, there has been a hue and cry from the usual proponents of super-secrecy that the lid be clamped on tight on all Vanguard information. If the test had been successful there would have been a mad scramble to take bows for the information effort.

But now, there is even talk of reprimanding Defense Department officials who did a superb on-the-spot job of making information available at Cape Canaveral. Nothing could be more ridiculous. Murray Snyder, Assistant Secretary of Defense for Public Affairs, and his deputy, Herschel Schooley, deserve a commendation for the way they handled the free flow of information from Vanguard. Far from being detrimental, this flow of information served a variety of useful purposes.

- **Prevent the American public** from ever again finding itself facing the ice-cold shocks of Soviet achievements such as the Sputnik launchings.
- **Provide the American taxpayer and voters** with a realistic understanding of the tough and costly job involved in achieving the scientific progress required to nourish our military strength and civilian economy.
- **Educate the American working press** and mass communications media in the same field so that they can report in a more accurate, sophisticated and balanced manner and avoid the tremendous pendulum swings from unbridled optimism to hopeless despair.
- **Convince this Administration** and those that will succeed it that government cannot operate effectively in a democracy either by concealing vital facts from the voters and taxpayers that support it or by promoting a steady glow of rosy optimism.

Most important of these is the long and arduous task of educating working press men and the American public on the hard facts of scientific development programs. The failure of the first Vanguard firing, while not surprising to technicians either here or abroad, removed some of the starry-eyed "magic" atmosphere with which both nontechnical newsmen and the American public regarded development of aircraft, missiles and space vehicles.

The Vanguard failure has begun to teach them that successful scientific developments are the result of costly and persistent experimentation that extracts from a series of initial failures the knowledge needed to lay the foundation for eventual success. The Soviets did not achieve their current success without following this bitter road of educational failure. The first 11 attempts to launch a Soviet IRBM were abortive, and it is pretty well established now that Sputnik I was preceded by an unsuccessful satellite launch in mid September.

If the American public is ever going to support an adequate basic research program and a sufficiently imaginative weapons development pace, it must understand the hard facts of the situation. It must stop chasing a mirage of quick miracles produced with scientific legerdemain by full blown genie at the eleventh hour in the same manner that Mickey Mantle or Ted Williams swat a ninth inning home run to win the ball game.

And this brings us to the second lesson to be learned from Sputnik and Vanguard. This lesson is the simple but vastly misunderstood fact that you can't win scientific ball games with ninth inning home runs, last second field goals or 80 yard passes. Where we stand today in scientific achievement and weapons development is solely dependent upon what we have done during the yesterdays of the past five to 10 years.

There has been a strong urge in top level government circles akin to panic since Sputnik to grab almost anything available off the scientific and hardware shelves to make some kind of a spatial demonstration. Some utterly meaningless schemes have been seriously considered to make a "propaganda" comeback in space.

Even the Army's Jupiter C launched satellite now comes close to this category, although in fairness to its originators they first candidly proposed it years ago when an "ashcan with a beep" would have been a sound initial step in a space program. A sphere of ice that would leave a vapor trail through the sky; a dye spot on the moon hurtled there by a lash-up of IRBM and research rocket motors; a luminous Christmas sphere of inflated aluminum foil, and many other equally ridiculous proposals have been seriously mulled over by the psychological warriors in the National Security Council.

There is nothing to be gained and a great deal to be lost in time, money and scientific talent from these hastily improvised lash-ups. The only way we can regain lost stature and achieve a continually widening margin of superiority is to lay the foundations now for a sound and continuous program of basic research, orderly but urgent development, and well planned, efficient production of new weapon systems.

There is no lack of sound ideas on how such a program should be organized and implemented coming from the best brains of the aviation and scientific communities. But so far, there has been a lack of administrative skill and decision in the executive branch of the government to implement any of these ideas and proposals and really begin the vital move toward a sound, long-term research and development program. This program must not be aimed at stern-chasing an adversary that is already off to a running start but paced to pass him in the critical years ahead and widen a significant margin of superiority for the future.

—Robert Hotz

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Harry P. Kupiec, president, Aircraft Equipment Testing Co., Baltimore, Md.

William Melanson, vice president, Cambridge Thermionic Corp., Cambridge, Mass.

John J. Bricker, vice president, International Business Machines Corp., New York, N. Y.

Orlando Torres, assistant to the president, Riddle Airlines, Inc.

Martin Goland will serve as director of Southwest Research Institute, San Antonio, Tex. Mr. Goland is vice president of the Institute.

Honors and Elections

At the 12th Annual Meeting of the American Rocket Society the following awards were made: **Thomas F. Dixon**, Goddard Memorial Award, for his work in rocket propulsion systems; **Reece Roth**, Massachusetts Institute of Technology student, $1,000 ARS-Chrysler Award, for his paper on a new method of measuring the velocity of hot gases; **Capt. Grayson Merrill**, (U. S. N., ret.), Pendray Award, for his rocket and jet propulsion literature; **Krafft A. Ehricke**, ARS Astronautics Award, for advancement of space flight; **William H. Pickering**, Wyld Memorial Award, for application of rocket power; **Capt. Levering Smith** (U. S. N.), Hickman Award, for his work in solid propellants.

Austin J. Tobin, executive director of the Port of New York Authority, has received the Order of the Legion of Honor from the government of France.

Changes

R. V. Lynch, sales manager-aircraft, and **G. M. Monroe**, sales manager-missiles, Chance Vought Aircraft, Inc., Dallas, Tex.

J. J. Alkazin, manager, Customer Service Dept., Convair, division of General Dynamics Corp., San Diego, Calif.

Fred Speaks, assistant director of marketing research and development, Ethel McCullough, Inc., San Bruno, Calif.

Carl E. Anderson, manager of manufacturing, and **Nicholas F. Frischhertz**, manager-spare parts and engine rebuild, Production Engine Dept., Aircraft Gas Turbine Division, General Electric Co., Cincinnati, Ohio. **Miles K. Wolfson** succeeds Mr. Frischhertz as manager of engineering.

Harry Schachter, production manager, and **Harvey O. Oberg**, hydraulics division manager, Wyle Laboratories, El Segundo, Calif.

INDUSTRY OBSERVER

► Air Force is still sitting on design proposals from five aviation firms for a hypersonic glide bomber with no decision in prospect until early next spring. Competing firms are Bell Aircraft Corp., which pioneered the concept in industry with its BOMI project (AW Dec. 2, p. 28); North American, which is offering a modified X-15 rocket plane with a million pound thrust booster rocket; Republic Aviation; the Martin Co. and Boeing Airplane Co. Latest intelligence from Russia indicates the Soviets have tested an 800,000 lb. rocket engine for their T-4A hypersonic glide bomber, and the prototype weapon system is close to flight test stage.

► Navy is considering proposal for a "slow fighter," whose slow speed would permit a relatively large, stable platform capable of carrying heavy avionic detection gear and a large number of long-range interceptor missiles. Chance Vought Aircraft and Hughes reportedly are working as a team on a long-range air-to-air missile that could be adapted to the project.

► Crash program is under way to develop and produce valves especially suited for ballistic missile service. Various types of valves and solenoids are suspected of being the cause of 76% of the malfunctions in both ICBM and IRBM firings to date. New program will involve an initial expenditure of $7,750,000 with nine contractors involved. North American Aviation has three contracts under the valve program. Other firms, each with one contract, include Aerojet-General, Robertshaw-Fulton Controls Co. and Wm. R. Whittaker Co. Ltd.

► Lockheed Missile Systems Division and Thiokol have made good progress with development of Navy's Polaris solid-fueled fleet ballistic missile test vehicles, but Navy has not yet made final design of the nuclear-powered submarine required to launch Polaris. Lag of the Polaris launching submarine is apt to be so far behind the operational status of the missile that Navy will have to push land and surface-based launching sites to use Polaris in the long gap until its submarines are in operation. Polaris test vehicle program with Thiokol rockets has reportedly been so successful that at least 50% of the scheduled test firings have been canceled. Aerojet-General is propulsion contractor for the operational missile.

► Titan intercontinental ballistic missile transportation loading trials using a Douglas C-133 are being conducted at Lowry AFB, Denver, Colo. In loading tests, full-scale Titan structural shell is mounted on dolly for wheeling into hold of C-133. Same scheme is planned for Convair Atlas ICBM. A program to modify the C-133s to carry the missiles is now under way (AW Dec. 9, p. 28).

► Doak Aircraft Co.'s X-16 VTOL being developed under Army contract is now in the final assembly stage and scheduled for rollout sometime next month. Aircraft is powered by Lycoming T-53s; engine-to-propeller transmission has gone through a 50 hr. test, structure has been static tested.

► Strategic Air Command has established a facility in Inglewood, Calif., for training personnel for operational capability with ICBMs and IRBMs. Site was formerly occupied by Robertshaw-Fulton Controls Co.'s Western Research Laboratory. When graduated from this preliminary training course, personnel will be sent to Cooke AFB, Calif., for field service training with ballistic missiles. Ramo-Wooldridge Corp. is assisting SAC in its educational program and is preparing various instruction manuals for the training course.

► Harvey Aluminum Corp., Torrance, Calif., is negotiating with Industrial Resources Division of the Air Materiel Command to build a rolling mill especially adapted for titanium alloys, with Harvey and Air Force each bearing half the machine's cost.

► Fact that latest firing of USAF Thor intermediate range ballistic missile fell short of target range is believed to have been caused by propulsion malfunction. Inertial guidance system, which received its first actual check-out in the firing, reportedly showed excellent performance.

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Washington Roundup

Education Effort

An organized effort is under way to convince the National Security Council that the American people should know more of the facts of life if they are to properly support a genuine U.S. effort to maintain technological capability.

Attendance of Vice President Richard M. Nixon at a quiet dinner party in Washington last week called by persons who are urging that the American people be given a frank appraisal of the situation gives substance to reports that he hopes to shake the National Security Council and conservative members of the White House inner circle from their "father knows best" attitude. Party was held at the home of William C. Foster, a vice president of the Olin Mathieson Chemical Corp. In addition to Nixon, guests included Paul H. Nitze, former chairman of the State Department's policy planning staff; Roswell L. Gilpatric, former USAF Under Secretary; Frank Stanton, president of the Columbia Broadcasting System; publisher John Cowles, and Laurance S. Rockefeller.

Nixon, who started preaching urgency while the White House guard still was referring to the Russian Sputnik as a "silly bauble," may be the man to press the cause of realism in the Security Council and even to the desk of President Eisenhower. There are overtones indicating this is part of his conflict with Sherman Adams, presidential aide who thinks the Soviets are only playing basketball in space.

Officially, Nixon professes that his big interest lies in the mutual security aspects of meeting Soviet competition, particularly the possibility of using political and economic measures to win friends in Asia and Africa.

Advisory Board's Potential

Among other Sputnik results may be increased recognition of the potential that could be realized from accepting advice from USAF's Scientific Advisory Board headed by James H. Doolittle. At a three-day meeting in Chandler, Ariz., the group made a detailed study of the problems of limited war, hearing from top experts in the military and scientific circles. In addition to the chiefs of staff, Central Intelligence Agency and Department of State representatives delivered top secret papers at the session. The board also has named a committee headed by Dr. H. Guyford Stever, former USAF chief scientist, to study the Air Research and Development Command and its related agencies and submit a program for improvement of USAF's scientific effort.

Vanguard Publicity

Rep. John Moss (D.-Calif.), chairman of the House Information Subcommittee, seems to be a congressional lone wolf in defending Defense Department's policy of providing advance information on just what was happening at Cape Canaveral prior to the abortive Vanguard launching.

Sen. Richard Russell (D.-Ga.), chairman of the Armed Services Committee, declared that it would have been better to have launched Vanguard "in the middle of the night, and then to have pointed to a satellite cruising in the heavens, than to have had all this fanfare."

Calling for a blackout on satellite launching attempts, Sen. Henry Jackson (D.-Wash.), chairman of the Atomic Energy Military Applications Subcommittee, said that Vanguard failure "doesn't really mean that we are as far behind the Russians as it might seem. But the publicity that will go out will be unfair to our efforts."

Moss, however, maintained:

"A fuller explanation of the real possibilities of success and failure should have been more strongly stated to the American people. Let us not kid ourselves with the feeling that we are any more embarrassed by this test failure than we will continue to be until we clearly demonstrate our ability to match the performance of Russia's Sputniks.

"Rather than more secrecy . . . we need more candor.

"Whether we admit failure or employ silence, the rest of the world will not credit us with success until we put a satellite into space."

Missile Acceleration

Maj. Gen. B. A. Schriever, commander of USAF's Ballistic Missile Division, has drafted a program to accelerate the operational capability effort by 25%. Details, he says, are classified, but it is evident that his recommendations apply in the main to the Atlas and Titan intercontinental weapons. The measures, Gen. Schriever says, have been "recommended to the proper authorities." He did not say how much they will cost, which probably is a factor the authorities will investigate.

Questionnaire to Industry

Senate Preparedness Subcommittee questionnaire to principal manufacturing companies engaged in the U.S. missile program (AW, Dec. 9, p. 25) places heavy emphasis upon research and development roadblocks and overtime cutbacks. Among the questions:

- **Has there been any limitation** imposed by the Department of Defense on the use of overtime?
- **Has research and development work** been hampered directly or indirectly by lack of funds?
- **Has insufficient manpower** held back research and development work?
- **Has research and development work** been delayed by change orders?

CAB Investigation

Staff of the Special House Subcommittee on Legislative Oversight under the direction of Dr. Bernard Schwartz is moving forward with its investigation of the Civil Aeronautics Board and has requested Air Transport Assn. for comprehensive data on its dealings with the Board. The subcommittee wants ATA to supply:

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Also in the party were Holaday and Wilber M. Brucker, Secretary of the Army and former governor of the State of Michigan.

There still was no indication of how the Jupiter production program will be funded, although the Army is proceeding on the assumption that it will produce the missile for USAF use.

German Delay in Ordering Aircraft Dismays Industry Sales Teams

By David A. Anderton

Bonn—German decision on interceptor and fighter-bomber purchases for major re-equipping of the revived Luftwaffe now is not expected before next spring.

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Question Marks

Other unknowns in the equation:

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mans will order both types of airplanes. But even within one specific mission there is still uncertainty. "We know they want to intercept," said one American engineer, "but do they want to do it in one quick pass or do they want some loiter time in the intercept area?"

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"The scientific importance of satellite projects is uppermost in our minds at the moment. But larger carriers, propelled into orbit by larger rockets, have tremendous military significance also."

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[illegible] telemetering [illegible] stages of Phase I. With the transmitter aimed

Education Effort

An organized effort is under way to convince the National Security Council that the American people should know more of the facts of life if they are to properly support a genuine U.S. effort to maintain technological capability.

[illegible] guest dinner party in Washington last week called by persons who are urging that the American people be given a frank appraisal of the situation gives substance to [illegible] hopes to have the National Security Council [illegible] members of the White House staff [illegible] "fully aware" attitude. Party was held at the home of William C. Foster, a vice president of the Olin Mathieson Chemical Corp. In addition to Nixon, guests included Paul H. Nitze, former chairman of the State Department's policy planning staff; Roswell L. Gilpatric, former USAF Under Secretary; Frank Stanton, president of the Columbia Broadcasting System; publisher John Cowles; and Laurance S. Rockefeller.

Nixon, who started preaching urgency while the White House guard still was referring to the Russian Sputnik as a "silly bauble," may be the man to press the cause of realism in the Security Council and even to the desk of President Eisenhower. There are overtones indicating this is part of his conflict with Sherman Adams, presidential aide who thinks the Soviets are only playing [illegible] game.

Socially, Nixon protests that his big interest lies in the mutual security aspects of meeting Soviet competition, particularly the possibility of using political and economic measures to win friends in Asia and Africa.

Advisory Board's Potential

Among other Sputnik results may be increased recognition of the potential that could be realized from accepting advice from USAF's Scientific Advisory Board headed by James H. Doolittle. At a three-day meeting in Chandler, Ariz., the group made a detailed study of the problems of limited war, hearing from top experts in the military and scientific circles. In addition to the chiefs of staff, Central Intelligence Agency and Department of State representatives delivered top secret papers at the session. The board also has named a committee headed by Dr. H. Guyford Stever, former USAF chief scientist, to study the Air Research and Development Command and its related agencies and submit a program for improvement of USAF's scientific effort.

Vanguard Publicity

Rep. John Moss (D.-Calif.), chairman of the House Information Subcommittee, seems to be a congressional lone wolf in defending Defense Department's policy of providing advance information on just what was happening at Cape Canaveral prior to the abortive Vanguard launching.

Sen. Richard Russell (D.-Ga.), chairman of the Armed Services Committee, declared that it would have been better to have launched Vanguard "in the middle of the night, and then to have pointed to a satellite cruising in the heavens, than to have had all this fanfare."

Calling for a blackout on satellite launching attempts, Sen. Henry Jackson (D.-Wash.), chairman of the Atomic Energy Military Applications Subcommittee, said that Vanguard failure "doesn't really mean that we are so far behind the Russians as it might seem. But the publicity that will go out will be unfair to our efforts."

Moss, however, maintained:

"A fuller explanation of the real possibilities of [illegible] to the American people [illegible] the feeling that we are not more enthusiastic [illegible] [illegible] should not be until we [illegible] [illegible] to match the performance of Russia's people."

"Rather than more secrecy . . . we need more candor.

"Whether we admit failure or employ silence, the rest of the world will not credit us with success until we put a satellite into space."

Missile Acceleration

Maj. Gen. B. A. Schriever, commander of USAF's Ballistic Missile Division, has drafted a program to accelerate the operational capability effort by 2½ years. Details, he says, are classified, but it is evident that his recommendation applies in the main to the Atlas and Titan intercontinental weapons. The measures Gen. Schriever says, have been "recommended to the proper authorities." He did not say how much they will cost, which probably is a factor the authorities will investigate.

Questionnaire to Industry

Senate Preparedness Subcommittee questionnaire to principal manufacturing companies engaged in the U.S. missile program (AW Dec. 9, p. 25) places heavy emphasis upon research and development roadblocks and overtime cutbacks. Among the questions:

- **Has there been any limitation** imposed by the Department of Defense on the use of overtime?
- **Has research and development work** been hampered directly or indirectly by lack of funds?
- **Has insufficient manpower** held back research and development work?
- **Has research and development work** been delayed by change orders?

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Crosley Height Finder has range, will travel

Hit-or-miss artillery fire was the first known use of America's antiaircraft weapons. So they are no more. Troops on the move also need warning of approaching hostile aircraft.

A new radar was needed. It had to be light enough for easy transport, tough enough to withstand campaign conditions, and powerful enough to scan heights beyond the reach of any device previously available. The assignment of designing, building and producing it was given to Avco's Crosley Division. The MPS-16 height finder is the result. Working in cooperation with the [illegible] Air Development Center, Crosley has given the Air Force and Marine Corps another great contribution for national defense.

THIS IS AVCO

Avco today is a diversified organization whose products include aircraft power plants and structures, electronics for defense and industry, and specialized home and farm equipment. Avco's divisions and subsidiaries are:

Lycoming—aviation, marine and industrial power plants...Crosley—electronics systems and aircraft structures . . . American Kitchens—kitchen equipment and architectural porcelain . . . New Idea and Ezee Flow—specialized farm equipment... Research and Advanced Development—missile and allied research . . . Crosley Broadcasting Corporation—the WLW radio and TV group . . . Moffats Limited (Canada)—commercial gas and heating equipment.

Scientists interested in unusual opportunities for advancement can grow with Avco.

Avco makes things better for America

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Moon missile would contain a modification of the ASI-developed telemetering equipment used in previous Farside firings of Phase I. With the transmitter operating intermittently, batteries could last for a number of days.

Object of Farside Phase II firing would be to impart just enough speed to take missile out of the Earth's gravitational field and into the Moon's gravitational field, relying upon the latter to draw in the rocket projectile with its payload of instrumentation and transmitter. Intent would not necessarily be to impact directly on the Moon but generally to place the projectile in the vicinity of the Moon to obtain environmental data.

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Other unknowns in the equation:

• **Detailed specifications** or requirements. Commonest complaint on the part of the technical sales people in Germany is the lack of definite specifications for the German airplanes. But this overlooks the natural tendency of a prospective buyer of aircraft to want to make one purchase that will do all the jobs for him. Most military airmen believe the Germans are realistic enough to know that an interceptor to meet their estimated defense problem is not going to be a good ground-support fighter-bomber. They believe the Germans will order both types of airplanes. But even within one specific mission there is still uncertainty. "We know they want to intercept," said one American engineer, "but do they want to do it in one quick pass or do they want some loiter time in the intercept area?"

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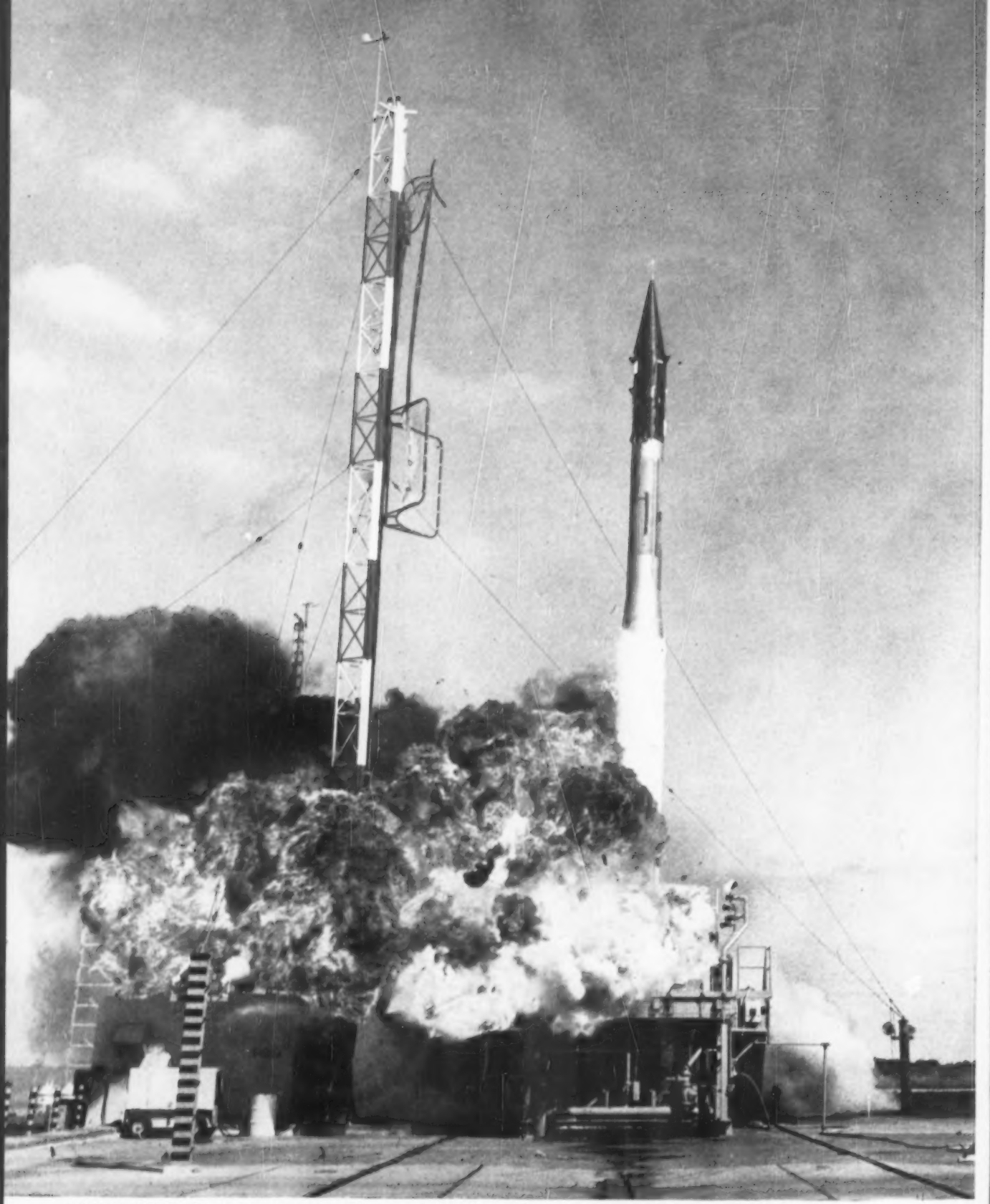
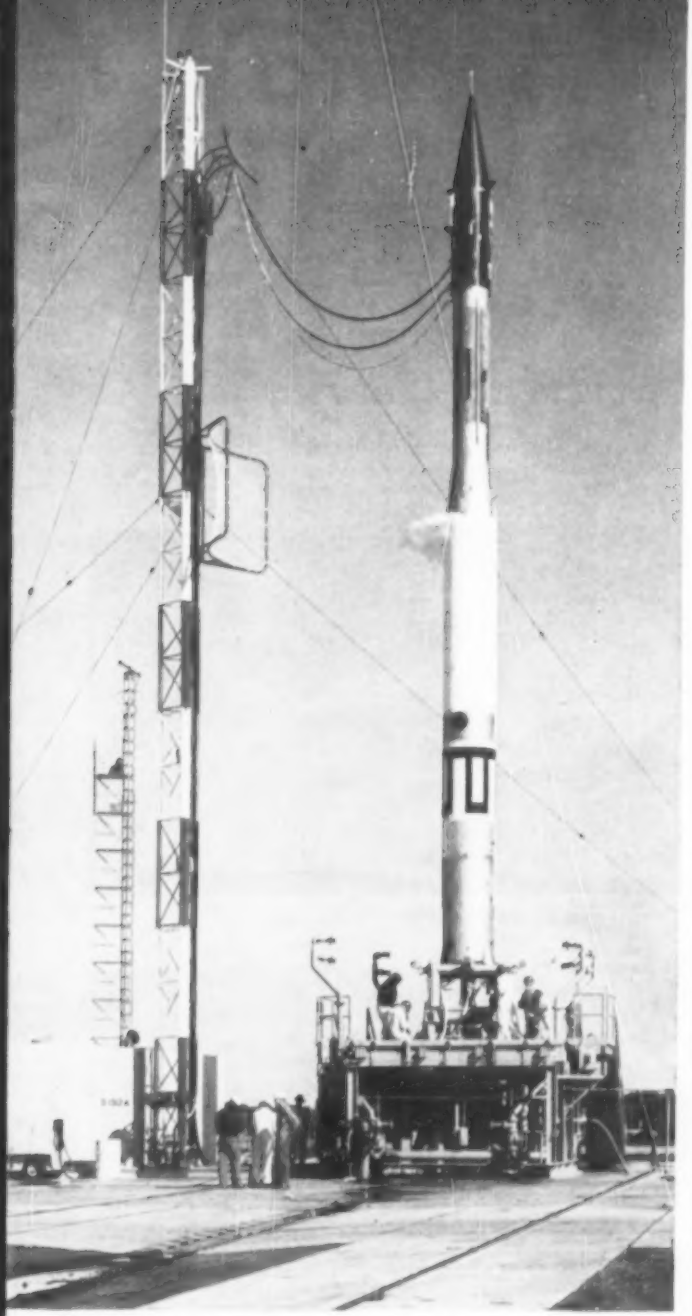
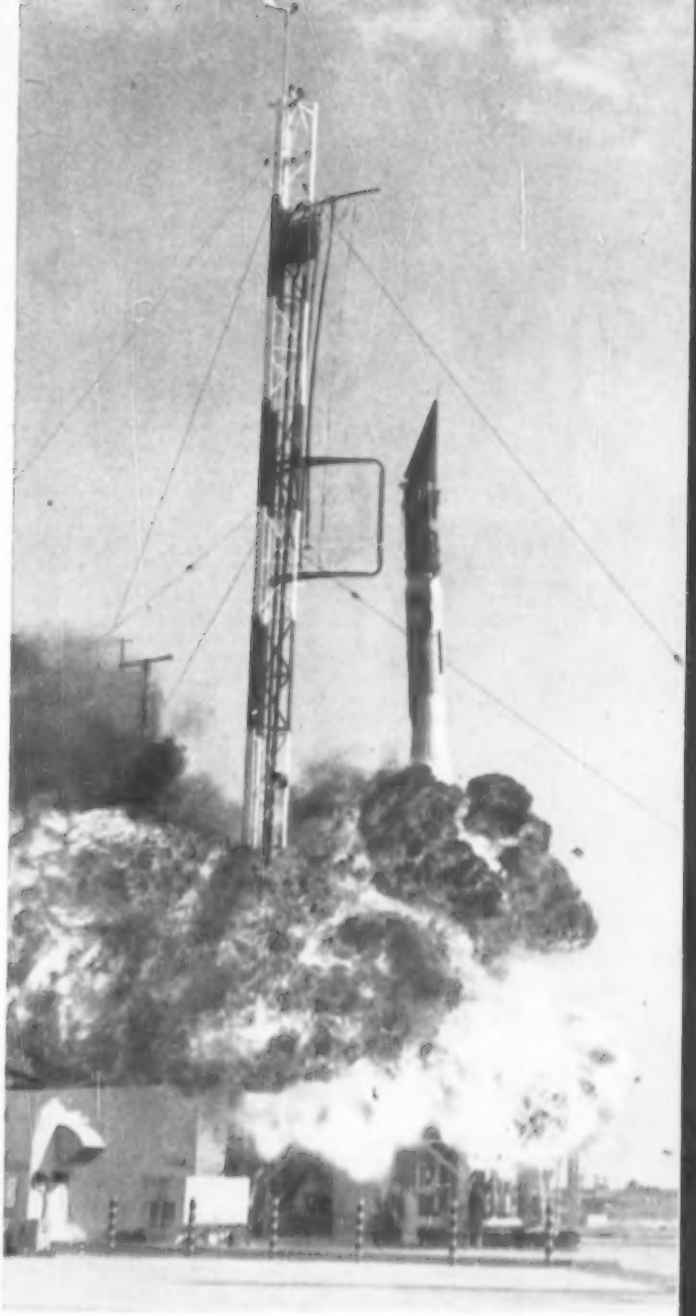


WIND WHIPS the first stage engine fire which ended Project Vanguard's first attempt to place man-made satellite in orbit.





VANGUARD pre-launch checks are made at left and the rocket's first stage is consumed by fire as the nose cone falls at right.

Defense Seeks Cause of Satellite Failure

Washington—Precise cause of the failure of Vanguard Test Vehicle 3 had not been discovered by late last week, and Defense Department indicated the reason will not be officially disclosed even if it is pinpointed.

Official statement was that the failure was caused "by a mechanical failure in the propulsion system, details of which are classified."

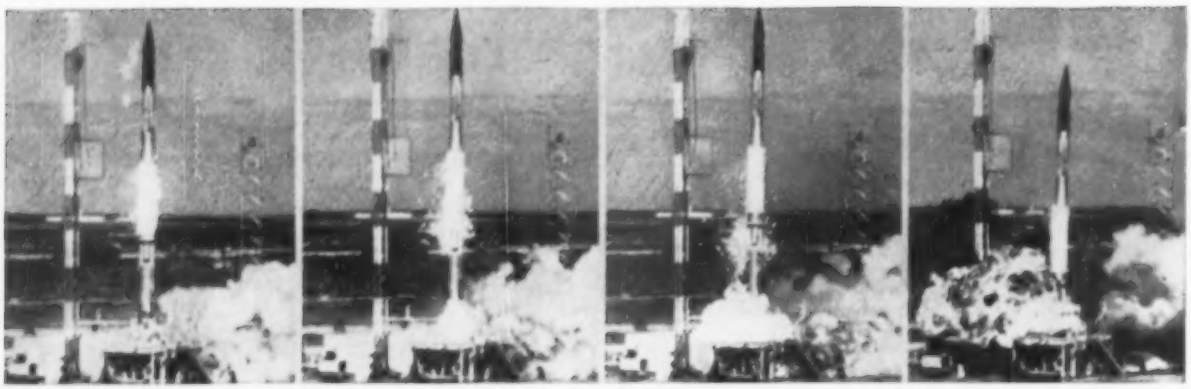
Vanguard officials said this meant the trouble had been "localized but not pinpointed."

Neither Defense nor Navy would comment on reports that the fault lay in the fuel pressurization system. Vanguard's first stage engine uses helium to pressurize the kerosene and liquid oxygen propellants, and hydrogen peroxide to drive the turbine that powers the propellant feed pumps.

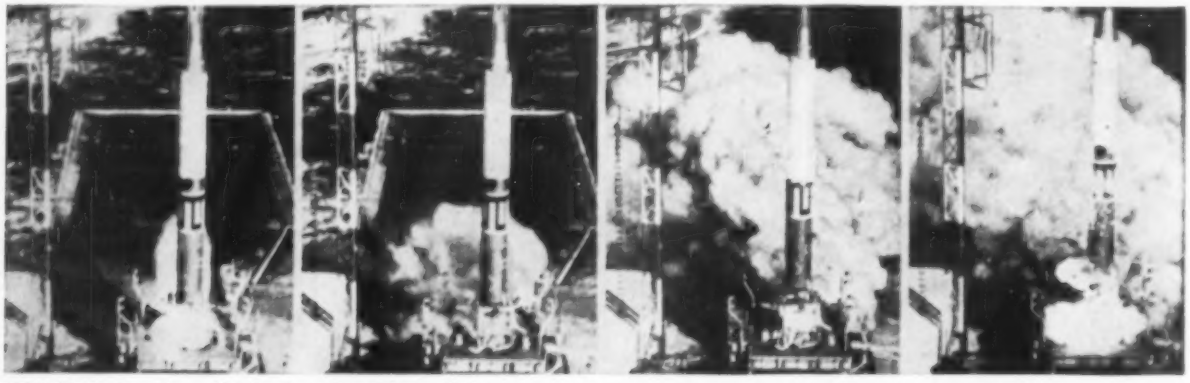
Launch attempt on Dec. 6 came after two days of delays caused by weather and minor technical problems. Ignition was achieved at 11:45 A.M. and the 22,000 lb. rocket rose two to four feet above its launching stand before thrust chamber pressure fell. TV-3 dropped backward onto the stand in flames, toppled over and broke in two.

Fire destroyed the first and second stages.

The third stage and the 4 lb., 6.4 in.



FIRST STAGE engine is nearing maximum power (left). Cloud of steam in the lower right of this picture is produced as the rocket exhaust is mixed with water in the blast deflector tube. In the second photo, the rocket rises slightly as vibration shakes pieces of ice away from the encrusted liquid oxygen tanks of the first stage. Fire has just begun in the immediate area of the engine. Fire ball grows in the third photo and the rocket settles and burns fiercely in the last picture.



SEQUENCE taken from slightly above launching pad shows engine raise the rocket a few feet before the fire begins (right).

Soviet Predicts Failure Of Vanguard

Moscow—Soviet missile experts publicly questioned the "practicability" of the U.S. decision to rush its experimental Vanguard vehicle into space almost two months before the satellite's failure at Cape Canaveral, Fla., earlier this month.

Shortly after their return from the CSAGI Rocket and Satellite Conference in Washington in early October (AW Oct. 7, p. 25), Soviet delegates to the meeting wrote in Promyshlenno-Ekonomicheskaya Gazeta (Industrial-Economic Gazette) that:

"The truth is that American scientists are experiencing difficulties with the rocket carrier, which still has not passed the stage of test stand trial."

The delegates said talks with American scientists showed that "American rocket technique is coming along well."

They added, however, that the American Earth satellite program "lags far behind Soviet techniques," and "the growing pains which we in the Soviet Union have long since overcome are still bothering American scientists."

test satellite were thrown clear. Although the satellite's battery-powered transmitter continued to "beep," the satellite was damaged too badly for further use.

Ordnancemen destroyed the third stage solid propellant engine.

Damage to the launch stand was "moderately serious," Defense Department said. Servicing tower and blockhouse were not damaged, and damage to the launch pad itself and the disconnect pole apparently were not severe.

TV-3 launching was to have been the first flight test of the 7,500 lb thrust Aerojet-General liquid propellant engine as well as the first flight test of all three engines in one vehicle.

Vanguard officials have maintained throughout the test program that the first test satellite might or might not be put into orbit, depending on the degree of success of each step in the flight, and that they considered the possibility of orbiting as secondary to logical procedure of test work.

But the impact of Sputniks I and II, the presence of more than 100 U.S. and foreign newsmen in the Cape Canaveral, Fla., area and Defense Department's attempts to release more information meant that the failure of TV-3 became more than an unsuccessful attempt to launch a developmental rocket. Results included these:

• **Tass, official** Russian news agency, abandoned its usual practice of writing unhurried and definitive dispatches and got detailed word of the failure to Moscow in bulletin form.

• **Newspapers here** and abroad criticized Vanguard officials, Defense Department and the Administration for "overpublicizing" Vanguard and reported public reaction—especially in Europe—reaction that ranged from disappointment to bitter sarcasm.

• **Defense Department,** which had not billed the firing as an attempt to launch the free world's first satellite, found itself trapped by its own attempts to release more news. At least unofficially, it reacted by clamping down hard on release of anything but routine information in the Cape area and began a study of whether TV-4 should be launched without a prior announcement.

• **Russia reacted** with taunts and Communist Party chief Nikita Khrushchev said Sputnik I's carrier rocket fell on U.S. territory but "the Americans will not give it up to us." U.S. denied that any part of the rocket fell on any U.S. territory.

Regulus II, Polaris Operational in 2 Years

By Russell Hawkes

Edwards AFB, Calif.—Navy's Chance Vought Regulus II Aerodynamic cruise missile and Lockheed Polaris fleet ballistic missile are both expected to reach fleet service at the same time in two years, Rear Adm. John E. Clark, director of Navy's Guided Missile Division, announced here at the first public demonstration of Regulus II.

Admiral Clark said there are roles in modern warfare for both cruise and ballistic missiles, repeating Navy's long-standing opposition to a doctrine based on one offensive weapon. He pointed out that while the ballistic missile undoubtedly has in its favor a margin of safety from enemy defenses, the cruise missile, with its variety of trajectories, is definitely not an easy target and an anti-ballistic missile is at least feasible.

Navy will eventually use its manned carrier air groups as weapons for "small wars," tactical use against mobile or hidden targets and to destroy enemy airpower near its own bases. While cruise missiles are capable of delivering a conventional warhead with great accuracy, Clark called it "a very expensive way to do the job." However, he granted that in a limited war a missile such as Regulus with a conventional warhead might be used on targets so heavily defended as to make attack by manned aircraft overly costly. He noted that a cruise missile such as Regulus could be used for reconnaissance.

RECOVERABLE training and test model of Chance Vought Regulus II aerodynamic cruise missile like one above made public 29-min. demonstration flight recently at Edwards AFB, Calif. Missile, powered by GE J79 (12,000 lb. thrust), reached 1,200 mph., 50,000 ft.

J79 Performance

Clark said that the General Electric J79 powered Regulus II has exceeded expectations in performance and reliability. Experts predicted that the recoverable test and training missiles would average two flights before being destroyed. In practice, they have averaged four, and one missile has been successfully recovered six times.

Several submarines and surface vessels, including U.S.S. Halibut, nuclear-powered cruiser U.S.S. Long Beach building at Fore River, Mass., are being constructed from the keel up to accommodate Regulus II or Polaris. Conversions are practical but difficult.

The stability of the ship can be imperiled by adding the weight of missile and hangar compartment above the ship's center of gravity. In a submarine, there is the additional problem of scaling out water under high pressure so as not to limit the depth at which the submarine can operate.

The normal lifetime of a submarine is 15 yr. and that of a surface vessel is 20 yr. Clark reports the Navy's normal replacement cycle will be able to put a number of ships originally designed as missile carriers into service fairly soon, limiting the number of conversions necessary.

Missile Stowage

Hangar space will normally be internal on both surface ships and subs. In an emergency, Clark says any ship with the necessary precise navigation system could be pressed into service as a missile carrier. In the case of submarines, this might require an external hangar similar to the oblong deck-stowed tanks used in the early Regulus I sub launching tests.

Several permanent hangar configurations are still being studied. Some of the problems aboard ship are cramped working spaces, handling of fuel and large parts, and preservation of access from one part of the ship to another. The host of environmental problems faced by shipboard missiles make them more expensive and more difficult to design than the land-based breed.

Inertial guidance can now place a missile within a few miles of a target 15,000 mi. away from the launching point since recent geophysical studies have brought the world's maps into register and more precisely determined the earth's shape. Because of drift of gyroscopes in the stable platform, some type of navigational assist often is required.

The need for an assist system is more urgent in an aerodynamic cruise missile than in a ballistic missile because of the longer duration of guided flight in which error can develop. Several types of assist system are still under discussion for Regulus II. Prominently mentioned are a Doppler system and a map matching technique with a radar, infrared or passive radar map presentation checked against an electronic overlay for position error.

Navy is seeking a passive, self contained guidance system to avoid the effects of enemy electronic countermeasures (AW Nov. 18, p. 50). The basic inertial guidance unit and the autopilot are the same as those used in Regulus I. This follows a policy set at the beginning of the project to use Regulus I components and techniques wherever possible.

Regulus II uses Mach number as a measure of altitude. It cruises at maximum continuous power with afterburner on and the signal from the machmeter controls altitude, calling for climb until the cruise level is reached. Service ceiling is listed only as "over 60,000 ft." But in view of the performance of manned aircraft which are also powered by the General Electric J79, it is probably also over 70,000 ft. Maximum speed is said to be "better than Mach 2" and in the terminal dive on target it is undoubtedly quite a lot better.

Missile Control

Recoverable test versions consistently outrun F8U chase planes. Stall speed is about 225 kt. Landing speed and speed at burnout of the rocket booster are set at 280 kt. to give a margin of stability and control. Longitudinal control is provided by elevons on wing trailing edge only about five feet aft of the missile's center of gravity.

Small fixed trapezoidal canard surfaces far forward and positioned with a positive angle of incidence of perhaps 10 deg. provide a longitudinal stabilizing moment to limit demands on the elevon

control system. Chance Vought engineers report that aerodynamically, Regulus II is unstable in some regimes. This was predicted in an early stage of design and is a penalty paid for high performance.

The autopilot is entirely able to cope with the instability. The missile is not maneuverable. Maximum rate of turn in cruise is one degree per second. Wing loading appears to be well over 150 lb. per sq. ft. Good maneuverability is not needed for the mission.

The 11-ton missile is lifted off the launcher by a single solid propellant booster rocket built by Aerojet-General. It is 20 ft. long and 20 in. in diameter with the nozzle canted 17 deg. below the missile centerline to direct the thrust line through the missile's center of gravity. Thrust is 115,000 lb. Burning time is four seconds. The 4,500 lb. booster is separated from the missile by drag and gravity.

Officers and men of Navy's Guided Missile Unit 55, the first operational unit scheduled to get Regulus II, are already working with Chance Vought experts at Dallas, Edwards and Naval Air Missile Test Center, Pt. Mugu. Navy usually draws personnel for its guided missile units from general line and submarine forces rather than from aviation units. For most of them, the handling of the missiles is a general quarters assignment and they have other responsibilities in the ship or boat.

Officers must be qualified underway watchstanders. Despite the general absence of aviation background, the units have developed a respectable capability in handling advanced aircraft engines and components during three years of experience with Regulus I.

The training and test model of Regulus II demonstrated last week telemeters test data on 200 channels and differs from the tactical versions in several respects. Fuel tanks are distributed differently and are drained in a special sequence to minimize center of gravity travel.

A water and glycerine ballast system serves the same purpose.

Radio command guidance system permits recovery and last minute variations in test program. Under control of a mother plane or runway portable unit, the missile is landed on heavy, retractable tricycle landing gear. A drag parachute released by the closing of a microswitch in the nose wheel shock strut cuts landing rollout.

Length is 57 ft., span is 20 ft. with wings extended and 8 ft. 4 in. with them folded. Folding vertical fin reduces overhead clearance needed by 42 in. Nose boom with pitot-static head also folds to cut length.

The demonstration flight lasted 29 min. The missile reached an altitude of 50,000 ft. and a speed of about 1,200 mph. Power was lost briefly but was regained without much loss of altitude. First flight of Regulus II took place May, 1956.

Free Enterprise Satellite?

Polyethelene satellite balloon, 24 ft. in diameter, which could be inflated after being placed in a 150 mi. high orbit by about $50,000 worth of solid fuel rockets is drawing interest from several advertising agencies. A major motor company, an oil company and a world-wide beverage company among others have been informed of the possibility.

Tracking the uninstrumented balloon would give data on variations in the Earth's magnetic field and the air density at the satellite's altitude. Time that the balloon remained inflated would be an indication of the meteor frequency. For the commercial aspect the balloon would be silvered and could have a few words written on it which would be visible in good weather with a pair of strong binoculars.

Programs for Future Sputniks Detailed by Russian Scientists

By Evert Clark

Washington—Forecasts on future Soviet Sputniks last week ranged from a prediction that Sputnik V will be able to jam radars and broadcast propaganda to a Russian outline for an orderly scientific program that still must solve the satellite re-entry problem.

Braking devices and wings will not be sufficient for re-entry, and some power will be required, Professor Konstantin I. Sergeyev wrote in the Communist newspaper Pravda.

Articles by Sergeyev and other Soviet scientists were printed in a full-page tribute to the 1,000th revolution of Sputnik I. They included the statement by Academician Leonid Sedov, chairman of Russia's Commission on Interplanetary Communications, that Russia experienced no failures in its attempts to launch its first two satellites.

Rep. James T. Patterson (R.-Conn.) told an American Legion Post audience in Middletown, Conn., that "the Russians at this very moment are rushing to complete the construction of Sputnik V, weighing over a ton and equipped with television receivers and transmitters, that the Soviets aim to place in an orbit 22,000 mi. above the earth. It will circuit its orbit once every 24 hours.

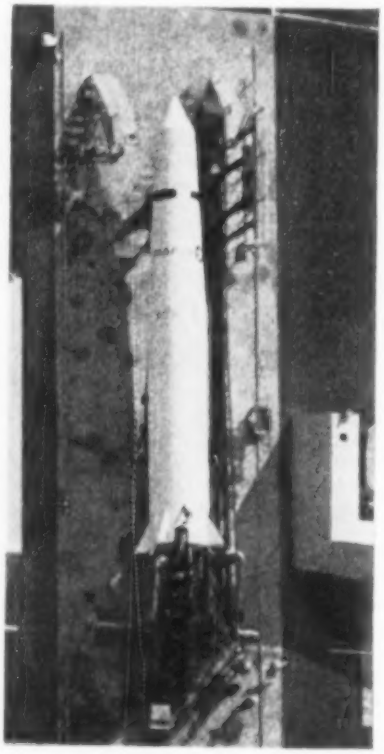
"Sputnik V will have the potential capability of jamming our early warning radar system, jamming radio and TV communications and broadcasting its own propaganda on any TV channel anywhere in the world, according to my information sources.

"Other Soviet satellites in the making will traverse the earth at lower altitudes and may be utilized as bomb-carrying vehicles."

Patterson said his information came from "the most reliable and authoritative sources." Other sources also predicted a jamming-broadcasting satellite but put the orbit at 50 mi.

The Communist magazine Radio, in June, 1956, printed an article proposing a world television broadcasting system consisting of three satellites in a common orbit at an altitude of 22,375 mi. They would be spaced 8 hr. apart in the orbit. Author V. Petrov said a number of problems remained to be solved and said exploration by earth satellite would be necessary to determine some of the answers. The article is reprinted in the Rand Corp.'s "A Casebook on Soviet Astronautics—Part II" (AW Nov. 25, p. 30).

Still another prediction, based on the translation of an article in a Russian astronomical journal, is that Sputnik III will release nitrous oxide at intervals in



order to leave a glowing trail across the sky.

Pravda's contributors looked toward moon colonization and "the investigation of circumsolar space," but only after solution of some problems.

Next steps, they said, are to send short-lived instrumented Sputniks to altitudes of 475 to 500 mi. for upper atmospheric studies, and to advise means for recovering Sputniks containing test animals.

Sergeyev said wings and brakes will not be enough. The satellite will need power of its own and "a small additional expenditure of fuel will be requered" for safe descent, he said.

Following that will come "eternal" satellites powered by solar energy and orbiting at great heights, to study dangers of cosmic radiation.

Next will come an essential part of the program—prolonged orbiting of animals at great heights and their recovery, to determine probable effects of cosmic radiation on man.

Man will follow—not in small satellites but in a permanent station built of final stages of cosmic rockets and orbiting between Earth and Moon. It would make use of solar energy to grow food and would rotate on its axis to create a state of gravity. Similar proposals have been made in the U. S.

"The present state of power development, plus the rational use of chemical fuels, particularly nuclear fuel, will enable us to accomplish all these tasks in the not so distant future, however complicated they may seem now," Sergeyev said.

Shuttles between Earth and space station and two-way trips from the station to the moon and planets would follow. Then would come a one-way trip to the Moon, probably from the station but possibly from Earth. Colonization of the Moon includes plans for living in caverns and creating an atomic power system, using lunar minerals. The colony would become the takeoff point for further explorations. Eventually, manned interplanetary ships will leave from Earth itself, Sergeyev wrote.

USAF Space Efforts Outlined by Sessums

Los Angeles—Research and development of propulsion systems designed to bolster present and future space travel efforts were reported here last week by Maj. Gen. J. W. Sessums, Jr., vice commander of the Air Research and Development Command.

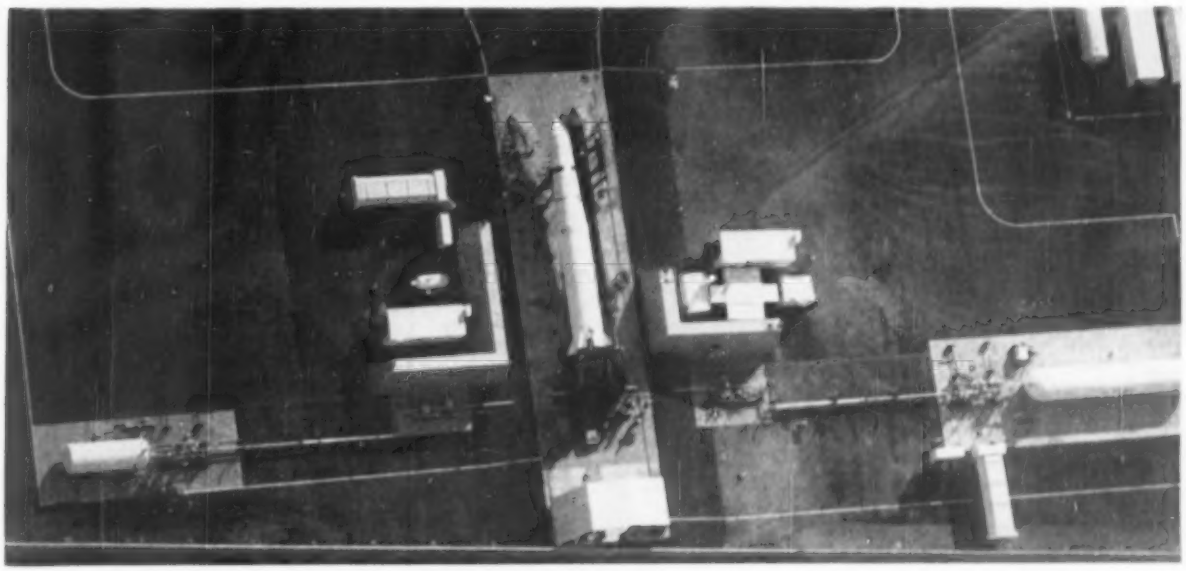
At the Advanced Propulsion Symposium sponsored jointly by ARDC's Office of Scientific Research and North American Aviation's Rocketdyne Division, Gen. Sessums said that, while the Soviets are ahead with hardware in space, they are not necessarily ahead in scientific conceptions, ideas and sharpness. He stressed that the U. S. must make proper investment today to insure development of the vital capability to control space.

During the current fiscal year, Gen. Sessums said that more than half of USAF's research and technical development funds are being directed into areas of study, research and development that will increase our capability for space flight. In the coming fiscal year, he said this percentage will be increased even more. He added:

"In the propellants area, we have an active program in high energy liquids, solids, and free radical fuels. One of our research projects last month provided a new possibility for synthesis of high heat content fuels promising a drastic reduction in cost. Although much work remains to be done, this has the earmarks of a breakthrough.

"For almost four years, the AFOSR has sponsored a non-proprietary research program of liquid rocket combustion in the industry and the universities. We meet regularly on an informal basis . . . to exchange information and discuss progress. The scope of this effort encompasses droplet behavior, reaction kinetics and most of the combustion phenomena which occur in the chamber of a rocket.

"Some understanding has been gained of combustion instability, heat transfer and the chemistry of reactions. This program has more than paid for itself in terms of development time and dollars saved. However, a sustained effort is still required to gain the understanding necessary for predictable scaling of rockets, and exploration into regimes of ultra high temperatures."



Thor Prepared For Inspection

Douglas Thor intermediate range ballistic missile is prepared for USAF design and engineering inspection at Douglas' Culver City, Calif., plant. Nose cone is dummy, but otherwise this is operational configuration. Photo taken last week shows fuel tank at extreme lower left (above), liquid oxygen tank at lower right. Helium is stored in tanks at left of missile nose. Douglas plant is tooled to produce up to 90 Thors per month, but is held to two by budgetary limitations. Operational nose cone with megaton warhead uses blunt corrugated configuration developed to solve re-entry problem. Engine is a 165,000 lb. thrust Rocketdyne unit.

FIRST photo of All American Engineering's tests with tailhook and arresting gear on USAF fighter. Engagement speed: 150 kt.

F-84F Tests New USAF Arrester System

By George L. Christian

New York—Prototype development of a carrier-type arresting gear for manned USAF fighters has been completed and service-tested by All American Engineering Co.

First photographs show trials being conducted with an F-84F at the firm's test center at Sussex County Airport, Georgetown, Del. Pilot was David F. McCallister, chief, engineering flight test.

May Reduce Accidents

All American officials believe their fighter arrester system will allow such commands as Air Defense Command to slice their accident rate by a considerable margin. They cite statistics which indicate that more than 50% of all Air Force accidents are relative to stopping aircraft on the runway. Typical of this category of accident are: undershoots because emergency forces the pilot to land on a shorter than normal runway, overshoots because of aborted take off, drogue chute or brake failure, skidding on wet or icy runway surface or swerving off runway because of tire blowout.

All American engineers feel that most if not all accidents due to these causes can be eliminated by use of the arresting hook in conjunction with an arresting engine such as the All American Engineering-developed water squeezer (AW Sept. 2, p. 90).

Progress toward equipping USAF fighters with arresting gear was made recently when Air Defense Command's formal requirement for a fighter arrester system, including installation of tailhooks on its Century series fighters, was sent to the Director of Requirements Office at USAF Headquarters.

McCallister told AVIATION WEEK that a desirable feature of his company's arrester system is the low G effect imposed on the pilot during an arresting operation. He said that, even at engaging speeds of 175-180 kt., deceleration forces do not exceed 1.7G. Low Gs result from programming the plane's arrestment over a 930 ft. runout. At lower engagement speeds of 90-120 kt., G forces are considerably lower according to McCallister.

All American's evaluation of the fighter arrester system involved a series of 75 landings and engagements. Company reports that the effectiveness and reliability of the system was proved by the fact that every engagement resulted in a safe, smooth stop. There were no failures or aborts.

Arresting hook is extended and retracted hydraulically by the pilot. All tests were made on a 5,000 ft. concrete runway using one hook-equipped F-84F and a similarly equipped F-84G.

Although the runway arresting engine can recycle for another engagement in as little as 17 sec. All American says that 30 sec. is a more realistic and practical recycling speed time.

Effect on Performance

McCallister says that All American made the hook installation on the F-84F with a weight penalty of 100 lb. The arresting hook assembly is supplied as a kit modification which can be installed by any USAF base.

No loss of performance is experienced on the F-84s when the hook is installed in lieu of the ventral drogue parachute according to McCallister.

However, when it is mounted beneath the drogue parachute, a slight drop at high Mach (.98 to .96) is experienced. Below Mach .90, performance loss is negligible, he says.

A single universal arresting gear to provide emergency stopping capability for all Air Force jets is not now practical because of the wide disparity in aircraft weights—ranging from about 12,500 lb. to more than 450,000 lb. But, All American says, just two arresting engines are needed, one for all fighter-weight planes and another for all heavy ships including bombers, tankers and large transports.

Republic Plans Early Jet Helicopter Sales

New York—First deliveries of French-designed Sud Alouette II jet-powered helicopter will be made next month by Republic Aviation Corp.'s newly formed Helicopter Div., Farmingdale, New York.

Initial Alouettes delivered by Republic will be assembled from components built by the French manufacturer; the U. S. firm plans to eventually produce the helicopter here by gradually phasing in increasing number of Republic-built components with Sud-built parts. Republic's territory covers U. S., Canada, Alaska, Hawaii, Puerto Rico and Central America.

Republic firmed up its plans to handle the Alouette after sponsoring a 26,800-mi. tour of the United States last summer with two Alouettes for market study purposes. Tour generated sufficient customer interest to warrant Republic setting up a separate division to handle sales. New division is headed by Herbert H. Munsey, formerly assistant vice president of Bell Aircraft Corp.

Four new

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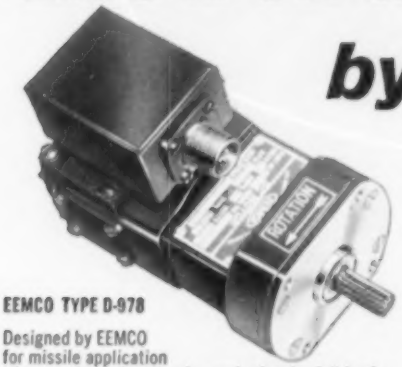
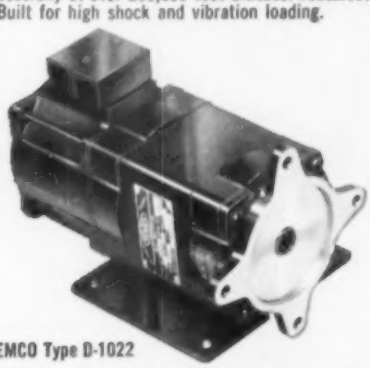
by EEMCO



EEMCO TYPE D-978

Designed by EEMCO for missile application where prolonged testing is required under full load at a temperature range of +180° F. to +400° F. **SPECIFICATIONS: Volts:** 27 volts DC (24 to 32 volt range). **Horsepower:** ¼ HP (⅔ HP max. short time overload). **R.P.M.:** 12,000. **Weight:** 2.75 pounds. **Miltary Specifications:** Radio noise filter meets MIL-I-6181B. Explosion proof requirement meets MIL-5272A-Proc. 2. **Altitude Operation:** Tested successfully at over 200,000 feet altitude. **Features:** Built for high shock and vibration loading.

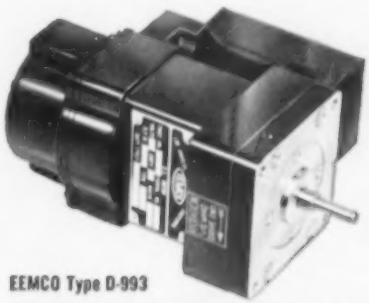
To design and produce motors for missiles that perform well beyond the limits of military specifications yet which maintain specified size and weight limitations is a constant objective at EEMCO. The design, development and testing of motors that achieve these extreme performance characteristics requires EEMCO to conduct company-financed independent research far beyond that normally conducted by a manufacturer of its size. In many instances EEMCO has been able to meet rigid specifications, in fact exceed them, when other producers have failed. For example, three of these extremely rugged new EEMCO motors illustrated will perform with reliability in the atmospheric conditions encountered at altitudes in excess of 200,000 feet, and they are built for unusually high shock and vibration loading. Please note the outstanding capabilities of the individual motors shown.



EEMCO Type D-1022

Designed by EEMCO for extremely high altitude operation with ambient temperature capacity to 165° F. Type D-1022 is capable of unusually high shock and vibration loading.

SPECIFICATIONS: Volts: 56 volts DC. **Horsepower:** 8.5 HP at 85% efficiency. **R.P.M.:** 12,000. **Duty cycle:** Two minutes. **Ambient temperature:** 165° F. **Weight:** 14.75 pounds. **Military Specifications:** Explosion proof requirement meets MIL-5272A-Proc. 2. **Features:** Built for high shock and vibration loading.



EEMCO Type D-993

Designed for missile applications where prolonged testing is necessary. Type D-993 will stand long idling periods with intermittent loads up to 1.25 HP. It is capable of withstanding vibrational accelerations of up to 125 "G's" in a frequency spectrum of 30 to 300 cycles per second.

SPECIFICATIONS: Volts: 28 volts DC (24 to 32 volt range). **Horsepower:** .65 HP. **R.P.M.:** 9600 RPM. **Weight:** 6.2 pounds. **Military Specifications:** Radio noise filter meets MIL-I-6181B. Explosion proof requirement meets MIL-5272A-Proc. 2. **Altitude Operation:** Tested successfully at over 200,000 feet altitude. **Features:** Built for high shock and vibration loading.

EEMCO Type D-899

Rated at 2.75 HP on continuous duty, EEMCO Type D-899 200-volt 400-cycle 3-phase motor is made with high temperature insulation allowing continuous operation at 3.5 HP or a correspondingly high ambient. D-899 contains an integral gear box.

SPECIFICATIONS: Volts: 200 volts, 400 cycle, 3-phase. **Load:** 2.75 HP continuous duty. **R.P.M.:** 3140 RPM. **Power Factor:** 83%. **Overall Efficiency:** 76% for entire unit including gear box. **Military Specifications:** Meets MIL-M-7969A (ASG). **Weight:** 11.25 pounds. **Features:** Type D-899 may be made splash- and drip-proof with minor alterations. Gear box, acting as motor support, places base at approximately the center of gravity of a motor-pump assembly thereby limiting extreme shocks and vibrations encountered in a missile.

EEMCO HAS DESIGNED and produced motors and actuators for missiles and aircraft exclusively for the past 15 years. It has made nothing else. Exhaustive research and testing aimed at perfection in the art of building these units has been a constant objective since EEMCO was founded. As a result, extreme precision and reliability has been attained in its products; therefore many of the latest missiles and aircraft being developed and manufactured for our Armed Forces today contain EEMCO motors and/or actuators.

Your inquiry is invited.

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Reports Hint NATO Favors G.91 Over Four French Light Fighters

Flight test reports from the NATO lightweight fighter competition are reported to favor the Italian Fiat G.91 over four French entries, but even Fiat, which has been listing the praises of its aircraft in company publications, is not claiming it has won.

Dr. Theodore von Karman, chairman of NATO's Advisory Group for Aeronautical Research and Development, which fathered the competition, told AVIATION WEEK in Pasadena, Calif., that reports of any such decision are premature, though he did not brand them as inaccurate. The AGARD committee on the competition will meet Jan. 8 to study the flight test reports and Dr. von Karman's evaluation, and is expected to make its recommendation then.

Authoritative NATO sources pointed out that the committee recommendations in turn will be passed on to the North Atlantic Council, a further indication that no formal decision has been made.

Italian and U.S. sources in Rome told AVIATION WEEK that the flight reports favored the Italian airplane but that the French, piqued by the decision, have refused to accept the airplane for their own use. In Paris, the French Air Minister confirmed to AVIATION WEEK that the French delegation to the NATO Military Standing Committee in Washington was opposing selection of the Italian airplane, but would not indicate whether this meant the decision already was made.

One possible basis of strong French irritation reported in Rome was that the engine powering the G.91—the Bristol Orpheus—is British, thus eliminating the French from both airframe and powerplant sales.

Fiat and Bristol announced last week signing of an agreement to build the Orpheus engine in Italy. The new agreement supplements one signed in 1955. Bristol will send an engineering team to Turin to give manufacturing assistance and advice, and Fiat will send engineers to Bristol to study production.

Negotiations are under way between Fiat and an unnamed German firm for building of the G.91. In making this announcement, Fiat added that the G.91 "as is common knowledge obtained the best result" in the NATO trials. This appears to be as much a reference to the G.91's availability during the trials, requiring the use of only one airplane although two were on hand, and its performance in meeting NATO requirements, as to any NATO decision.

One solution to French opposition, reported to AVIATION WEEK in Washington, would be a compromise, providing for orders for both the G.91 and one of the French entries. They are the Dassault Etendard IV and VI (see cover), the Sud Baroudeur and the Breguet Taon.

When the competition ended, the most likely outcome expected then was a recommendation to the various NATO country foreign ministries to consider one or more of the five entrants (AW Oct. 28, p. 50). Unofficially, there were doubts from various nations that the lightweight fighter would ever become in reality a serious production program (AW Sept. 30, p. 26).

Although Dr. von Karman said there would undoubtedly be some hurt national pride in the selection, he said the only official objection he had from the French was to the wording of some parts of the firing test reports. This he classed as relatively minor.

Considerable confusion followed the first reports that the Fiat airplane was favored. Among the reasons:

- **Attempts by Fiat** to sell the airplane to Germany outside the light fighter competition framework. Not much hope is conceded for this effort.
- **Numerous cross-licensing** moves, largely routine. Besides the Fiat-Bristol arrangement, Dassault also is negotiating with Fiat. Breguet is tied to Dornier.
- **NATO committee** which will make recommendation to SHAPE is an ad hoc committee. This means the committee is on its own and not the responsibility of either NATO or SHAPE.
- **Austrian interest** in the airplane. Dr. von Karman said an Austrian pilot was allowed to fly the G.91 during the trials, and Austria has been greatly interested since. However, this has no connection with the NATO competition.

Curtiss-Wright Asked For $5.5 Million Rent

Washington—Curtiss-Wright Corp. is being asked for approximately $5.5 million in rent on government-owned facilities at its Wood-Ridge, N. J., plant, which the General Accounting Office charges the company has used for commercial production over the past seven years.

USAF's Air Materiel Command and Curtiss-Wright have agreed upon a hearing before the Armed Services Board of Contract Appeals on Jan. 7. This date was set Nov. 20, according to the Air Force.

Meanwhile, after the report on the claim against Curtiss-Wright by General Accounting, which was submitted to Congress on Nov. 27, Rep. Edward Hebert (D.-La.), chairman of the House Armed Services Investigating Subcommittee, announced last week that a public hearing on the question would be held by his group on Jan. 7.

Curtiss-Wright challenged Hebert's plan for a public congressional hearing, declaring: "The case to settle this dispute is set for Jan. 7 before the Board, and Curtiss-Wright will then present its entire evidence in justification of its refusal to pay what it claims is an exorbitant demand. . . .

"Any ex parte comment furnished the press by one holding a high government position concerning the validity of the government's claim prior to the trial of the entire case is an affront to Curtiss-Wright and can only be justified as an effort to prejudice this contractor in the eyes of the Board of Contract Appeals . . . ."

John Courtney, counsel of the subcommittee, said the General Accounting Office report was submitted to Congress Nov. 27 because at that time there was no decision by the Air Force to press the claim.

Speed Try Disqualified

Edwards AFB, Calif.—First attempt to break world speed record in McDonnell F-101 Voodoo by USAF Maj. Adrian Drew was disqualified due to a faulty timing camera. A light leak in the camera streaked several frames making it impossible to identify the airplane. Federation Aeronautique Internationale rules allow other attempts to be made within seven days of the original date.

Drew's other runs were made later in the week. Target speed was 1,200 mph., which is several times the one percent improvement on the former record required by FAI. Speed of the first day's runs was unofficially estimated at 1,180 mph., still fast enough to be a record if they had been accepted but less than target speed due to the fact that outside air temperature was 4.5C above standard.

Runs were made along a 10.1 mi. east-west course at an altitude of 39,100 ft. Drew put in 20 hr. practice over the course before making the first attempt. He reported difficulty in holding altitude within the stringent limits set by FAI because almost any measurable control deflection can cause gain or loss of several hundred feet in a fraction of a second at such high speed.

He was using both hands on the stick during the timed part of the run. Paint was blistered on the wing and stabilizer tips and on the nose by heating that occurred in the two runs. Skin temperature reached 195F.

Midway Traffic Jams Clog Entire System

Chicago's overburdened Midway fights volume that exceeds capacity; customers shy away from O'Hare.

By L. L. Doty

Chicago—Chicago Midway Airport, focal point of the nation's busiest airways, is fighting a volume of traffic that often exceeds peak capacity during at least nine hours of a 24-hour period.

Ranking first among all airports in the U.S. in the number of total annual aircraft operations, Midway is the source of traffic jams that can spread throughout entire airline systems in the form of flight delays and cancellations. The backlogs often occur in good weather as well as bad.

The saturated condition of Midway is an old problem to Chicago. Air traffic demand at the airport hit a ceiling more than four years ago and controllers have been battling to untangle traffic snarls and bottlenecks ever since. Only immediate relief lies in a more extensive use of modern O'Hare Field, largest airport in the U.S. and one of the few already tailored for jet transports.

But O'Hare, built to serve as Chicago's prime airport, is never filled to capacity and last year ranked 36th in the number of aircraft operations among U.S. airports. This anomalous situation is caused by the average passenger's reluctance at being scheduled through O'Hare because of its inconvenient location. As a result, airlines are reluctant to switch flights from Midway because of past experiences in revenue losses when such a move is made (AW Nov. 25, p. 38).

Midway's Limitations

Under the best of circumstances, Midway's tower cannot possibly handle the number of flights scheduled to and from Midway during at least nine hours of a midnight-to-midnight period when IFR conditions prevail.

For example, between 4 P. M. and 5 P. M., a total of 68 airline movements is scheduled. At the present acceptance rate, the tower can handle no more than 58% of these flights. And this percentage is sustained only if no unusual interruptions in control routine takes place.

Inability of the tower to cope with the volume of scheduled airline movements exists to a lesser degree for the entire period between 1 P. M. to 8 P. M. whenever weather conditions call for IFR operations. This bottleneck of traffic is squeezed tighter by an estimated 10 itinerant flights per hour seeking entry to Midway during daylight hours.

The same situation holds from 8 A. M. to 10 A. M. During the hour between 8 A. M. and 9 A. M., 83% of the scheduled aircraft movements can be handled and, during the next hour, the tower can accommodate about 90% of the scheduled landings and takeoffs. For the balance of the morning, scheduled movements are less than the airport acceptance rate but the backwash of flights in a holding pattern during the 8-10 A. M. period often hikes traffic volume well above the scheduled rate.

Chain-Reaction Delays

It is this backlog that causes an overflow of traffic into the late night hours when scheduled movements would normally subside. But holding stacks are commonplace during bad weather even after the 8 P.M. traffic rush has eased. And a delayed flight performance at Midway can easily cause a chain-reaction of delays that spill over into the following day's operation from coast to coast.

Under VFR conditions, the tower can handle between 80 and 90 movements per hour when dual runways are used. Midway is one of the few U.S. airports equipped with a dual runway configuration but the advantages of the dual system are often lost when pilots of larger aircraft such as the Douglas DC-7 or Lockheed 1049G demand the use of the longer of the two runways available.

When dual runways are not used, operations are cut to between 60 and 70 movements an hour. As a result, the 68 air carrier movements between 4 P.M. and 5 P.M. come perilously close to the peak acceptance rate when only one runway is used even with weather conditions well above normal.

During IFR conditions, the tower can handle as many as 45 movements per hour. Whenever the tower is forced to revert to time separation of aircraft because the radar equipment has been rendered useless by heavy precipitation, 30 movements an hour is considered the top figure.

Most operators term Midway a "DC-3 airport." Its size was doubled immediately after World War II when railway tracks bordering the north side of the field were razed and runways were extended into an adjacent golf course. The improvement enabled Chicago to keep pace with normal air travel growth following the war but any further expansion designed to untangle congestion is virtually impossible.

The airport is surrounded by obstructions that require glide slopes on the runways ranging from 5.1 to 39.1 deg. As a result, field limits are 300 ft. ceiling and three-quarters mile visibility, well above the usual standard of 200 ft. and one-half mile.

There is no dearth of runways. Few major airports can match the pattern of seven runways that should permit traffic flow from any direction and allow simultaneous takeoffs and landings. But the runways are short by modern standards and the field has but one ILS and one runway is equipped with high intensity approach lights.

The longest runway—situated on a northwest-southeast angle—is only 6,410 ft. in length. It is paralleled by a runway 4,856 ft. long. Three parallel runways, angled at a northeast-southwest position, are 5,900 ft., 4,857 and 3,326 ft. in length respectively. This crosshatch of runways is overset by two runways—one 4,717 ft. in length running east-west, the other 4,613 ft. running north-south.

The City of Chicago has studied a number of possibilities for extending the runways but any increases will be insignificant because of the thickly settled residential and manufacturing areas that clutter the periphery of the field. There is no chance that runways can be expanded to handle intercontinental jet traffic.

Outdated Radar

The ILS equipment is located at the northwest end of the 6,410 ft. runway. Midway landing limits prevail when direct ILS approaches are possible. However, when approaches on this runway are from the southeast in a traffic circle, limits are hiked to 500 ft. and one and one-half miles, one of the highest in the country for a major airport. Time intervals between aircraft in such an event climb to five minutes as compared with two minutes under normal IFR operations.

Midway was the first U.S. control tower to be equipped with radar. But the outdated ASR-1 with two repeater scopes is not equipped to take a circular polarization antenna so that heavy precipitation forces controllers to resort

to ANC clearances or time separation of aircraft.

Civil Aeronautics Administration plans to correct the radar problem this winter by replacing the ASR-1 with an ASR-3 radar equipped with circular polarization. ASR radar, coupled with dual ILS equipment, is a prime objective of the CAA's six-year plan at all major U. S. airports.

Airlines have moved only an insignificant number of flights to O'Hare, and the gap left by those flights has immediately been filled by additional services into Midway. Last year, the number of movements at O'Hare climbed to 44,414 from a 1956 total of 24,202. Despite this, aircraft movements at Midway have remained virtually the same since 1953. That year, 331,000 movements were handled as compared with 372,000 in 1956.

O'Hare Advantages

O'Hare Field is designed in a pinwheel pattern with four runways tangent to a central terminal hub. Longest runway, opened in September, 1956, is 8,000 ft. long and can be extended to 17,000 ft. if necessary. A second runway is 7,435 ft. long, and two others are about 5,700 ft. long. Additional runways are planned by the City of Chicago.

Landing limits are 200 ft. and one-half mile. There are no restrictions on glide angles since the field is clear of obstructions. The field is navigationally superior to Midway, but passengers rebel against flights scheduled from O'Hare because of its greater mileage distance from downtown Chicago.

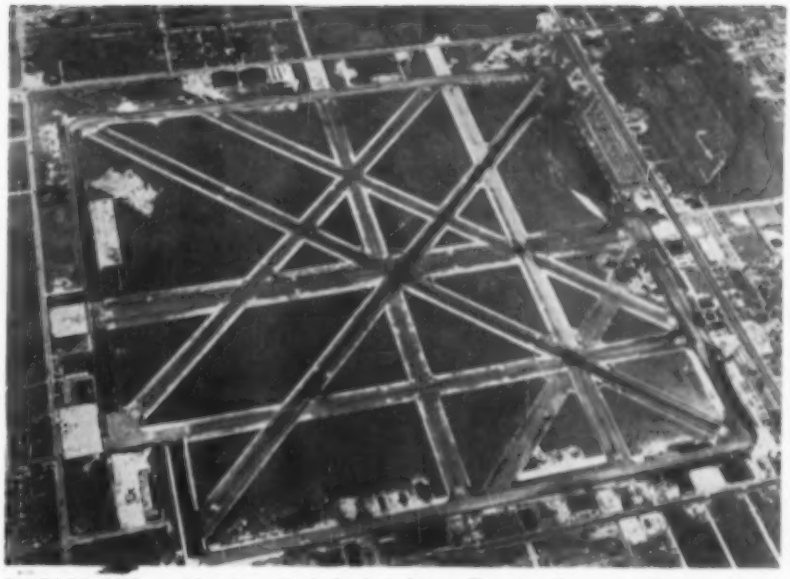
Although the City of Chicago is constructing an expressway to O'Hare from the downtown area, progress has been slow, and the surface trip to the field remains devious and time-consuming.

Target date for a new throughway to O'Hare is 1959.

Surface transportation is the deciding factor in a passenger's choice of airport. According to Chicago airline officials, however, the passenger's feeling for Midway is "psychological" since the time distance to either airport is exactly the same during city rush hours.

One Chicago airline official told AVIATION WEEK that Chicago passengers are suffering from a "mental block" in their insistence on being scheduled through Midway.

Time from the Chicago Loop to O'Hare by limousine service is one and one-half hours, and service is available from all airline ticket offices on departure schedules tie-in with airline schedules. Limousines to Midway depart from the Loop every 10 minutes regardless of airline schedules, do not operate directly from all ticket offices and take one and one-half hours during the rush hour; one hour and fifteen minutes at other times.



CHICAGO Midway Airport, nation's busiest, hit traffic saturation point four years ago.

The average geographical center of passenger destination and origin is at a point on the southwest corner of the Loop which, psychologically, implies a shorter traveling time to Midway on the southwest side of the city than to O'Hare on the northwest side.

A total of 35% of Chicago passengers begin their trips with the Loop; 39% arrive at the airport by private automobile, 34% by taxi and 21% by limousine. Taxi fare to Midway is less than that to O'Hare, but traffic conditions for the private automobile driver to either airport are about equally congested. Midway cannot be considered easily accessible by any standards.

Airlines Stick to Midway

This antipathy of passengers for O'Hare is largely responsible for airlines refusing to move a more substantial number of flights over to O'Hare. As a result, O'Hare is without an adequate service pattern, good connections and convenient schedules.

Only United Air Lines has established a service pattern at O'Hare which promises to insure the airline a steady flow of profitable traffic independent of O'Hare. A number of regional trunklines and all of the local service carriers cling to Midway because of the importance of Midway's connecting traffic in sustaining payloads.

Many larger carriers are equally unwilling to make the move. American Airlines, for example, operates all its Chicago-Los Angeles nonstop flights—first-class and coach—from Midway. Its Chicago-Washington flights are operated only from Midway and only four of its 24 nonstop roundtrip flights between New York and Chicago are serviced at O'Hare.

Braniff Airways has only one flight into O'Hare. Capital operates 48 flights into Midway from the east and schedules only local flights into O'Hare.

Northwest uses only Midway on westbound flights, and Continental serves only Midway with all its flights. Trans-Canada Airlines serves only Midway. TWA operates 24 west-bound flights from Midway but only one flight to Wichita and one nonstop coach flight to Los Angeles are scheduled out of O'Hare. Whether the Chicago problem will be resolved within the near future is in the hands of scheduled airlines, the City of Chicago and the CAA.

The city is waiting for the results of studies recently conducted by the CAA Technical Development Center in Indianapolis to determine the best sites for the new runways at O'Hare. It also is moving ahead with the improvement of one throughway—Congress Street—in order to improve city-airport connections at O'Hare. However, a completed highway direct to the airport does not appear likely for several years.

The Civil Aeronautics Administration is required by mandate to continue to accept the traffic demands imposed upon it until the volume reaches proportions the CAA considers hazardous. At present, the overcrowded conditions are being handled by controllers with a competence which one airline official has termed "fantastic" despite a controller experience level of approximately 45%. Another airline member described the Chicago tower as "one of the most efficient in the country."

Most airline officials realize the necessity of relieving Midway's congestion by transferring flights to O'Hare. But the

high average of 26 passengers per flight at Midway causes an understandable hesitation in moving into a split operation that may deprive the carriers of an important source of revenue. And no carrier will willingly maneuver itself into an unfavorable competitive position in the Chicago air travel market that, last year, generated nine million arriving and departing passengers.

Delta Head Warns Fare Denial May Mean Return to Subsidy

By Ford Eastman

Washington—Unless the Civil Aeronautics Board grants a fare increase, the price of re-equipping U.S. airlines for the jet age may force a return to subsidy or nationalization of the industry, Delta Air Lines President C. E. Woolman declared last week.

Testifying in CAB's General Passenger Fare Investigation, Woolman said a 15% fare increase would restore Delta's earnings to an adequate level and permit the airline to finance its equipment programs of the next four years on a sound and business-like basis.

'Prompt Approval'

Woolman was the third airline president to take the stand in the case to ask for a fare increase. The first was C. R. Smith, of American Airlines, who also asked for a 15% increase (AW Nov. 25, p. 45). He was followed by Charles E. Beard, Braniff Airways, who urged a minimum of 12.5% increase in passenger fares (AW Dec. 9, p. 43).

The airlines contend the need for an increase is acute because of a continuing decline in profits that will repel investors at a time when industry must raise large amounts of money in order to break into the jet age.

"We believe," Woolman said, "that only through prompt approval of this proposed fare increase can the Board discharge its responsibilities under the developmental philosophy laid down by Congress in the Civil Aeronautics Act."

As an example of the inflationary pressures with which Delta is confronted, Woolman said the airline granted substantial increases in general wage and salary levels in 1956. Pilots also received substantial increases. Costs of materials, he said, are constantly increasing in all categories, including progressive increases in the costs of engines and spare parts.

The Delta president said his airline's unit operating expenses have been on the upward trend for well over a year. The cost per available ton-mile for the 12 months ending Mar. 31, 1957, was 27.74 cents; for the year ending June 30, 1957, it was 27.84 cents, and for the year ending Sept. 30, 1957, it was 28.23 cents.

Of greater concern, Woolman said, is the rapidly decreasing spread between unit operating revenues and unit operating expenses. He said Delta's operating margin—in cents per revenue ton-mile—has decreased constantly since mid-1956. The margin, he added, has declined from 7.13 cents per revenue ton-mile for the year ending June 30, 1956, to 3.85 cents for the year ending last June 30. The airline forecasts that this spread will be down to 3.04 cents for the year ending Dec. 31 and down to 1.87 cents next year.

As an example of the narrow spread between expenses and revenue, Woolman said Delta's total net earnings the past year was equal to the revenue from one passenger and his excess baggage on every flight. Just two or three additional days of bad flying weather would have eliminated that revenue, he added.

Woolman also testified that the drop in airline stocks rules out any hope of raising sufficient equity capital to aid in buying jets. He said Delta's stock in July, 1956, sold for $37 a share. By Aug. 5 of this year, it had fallen to $23.625 and, by Oct. 28, to $17.625.

Security Market

Delta began a program a year and a half ago through which it hoped to acquire additional capital funds and keep a reasonable balance of debt and equity. Woolman said the program called for not more than 50% of the total capitalization being represented by debt financing.

"In our planning," he told the CAB, "we have always viewed the 50% as a desirable maximum at the peak point with the average being somewhat less than that. Yet, the collapse of the airline security market has made the acquisition of further equity a practical impossibility, and it appears that we may now have to go to a ratio of debt capital as high as 68% at our peak demand point if we are not able to improve our earnings to the extent necessary to increase our equity by retained earnings and support additional sales of equity capital."

In a trial brief filed with the CAB earlier, Delta said it was committed to take delivery on 33 additional aircraft during the 1957-1962 period. To be delivered are five C-46 all-cargo aircraft, 10 DC-7B's, eight DC-8's and 10 Convair 880s.

The airline said its required funds needed between July 1, 1957, and June 30, 1961, would total $116,503,000, a figure which makes no provision for acquisition of any turbine-powered aircraft for replacement of Delta's present fleet of DC-6 and Convair 330/440 equipment.

To meet the requirement, Delta said it appears $39,958,000 will become available from depreciation on flight equipment; $3,878,000 from depreciation on ground equipment; $5,117,000 in the form of deferred income taxes; $13,022,000 from the sale of flight equipment and $160,000 through the amortization of deferred charges—for a total of $62,135,000 available through internal sources.

Under a credit agreement entered into in 1956, Delta established a total of $30 million in long-term commercial bank loans, of which $17,400,000 had not been drawn down as of June 30 of this year.

New York Airways Wants Vertol H-44Bs

New York—New York Airways is considering a switch from Sikorsky to Vertol H-44B equipment having a water tight fuselage bottom and three inflatable floats weighing 340 lbs. for Manhattan Heliport operation.

Robert L. Cummings, Jr., president, said the tandem-rotor helicopters might be in use in late spring of 1958. A Vertol helicopter was flying from LaGuardia Airport last month with New York Airways personnel aboard for evaluation.

The plan calls for purchase of five 15-passenger 44Bs with spares at a price of about $2 million. New York Airways would dispose of its present fleet of three S-58s and five S-55s to another operator and negotiations for the sale are under way.

The Vertols, selling for about $300,000 each, would be piston-powered. Vertol has been test-flying General Electric T58 and Lycoming T53 engines, however, and if such turbine equipment became available it could be retrofitted into the 44Bs.

Consummation of such a transaction, Cummings pointed out, is subject to Civil Aeronautics Board approval.

MATS Bailment Plan Protested by ATA

Washington—Air Transport Assn. last week filed a protest with the Military Air Transport Service against a MATS proposal that calls for the operation of 10 military aircraft by commercial carriers on Atlantic and Pacific routes.

Under the proposal, airlines would

Lockheed Electra Makes First Flight

Seven weeks ahead of schedule, Lockheed's turboprop Electra transport lifted from Burbank runway at approximately 90,000 lb. gross weight after just less than 1,900 ft. takeoff run on its first flight Dec. 6. Chief engineering test pilot Herman Salmon, with Roy Wimmer as copilot and flight engineers W. E. Spreuer and L. W. Holland, accomplished a 1 hr. 15 min. first flight during which preliminary maneuvers, according to Salmon, indicated excellent handling characteristics. Aircraft's Allison 501-D13 turbine engines driving Aeroproducts 606 propellers performed excellently as had been indicated by earlier propulsion system tests in the "Elation" test bed. Engineering flight evaluation report on Elation power packages was detailed in Aviation Week Oct. 14, p. 93. Flown twice Dec. 6, airplane had made three long flights by Dec. 10.

be required to operate five C-118s in the Pacific area for the transportation of passengers and five C-54s in the Atlantic for the movement of cargo. The service, which MATS wants to begin on Feb. 1, is designed to determine the advantages or disadvantages of having military air transport aircraft operated by civilian companies in regular military air transport service, in test exercises and in support of MATS war plans.

The Air Transport Assn. termed the proposed bailment program unsound and cited these reasons for its opposition:

- **Program lacks** most of the vital characteristics of a commercial operation. An airlift program based on equipment bailment eliminates the incentive for operators to acquire their own aircraft and prevents them from supporting the nation's transport manufacturing activity. It also eliminates the incentive for fleet modernization.
- **Although the program permits** an operation without capital risk, it introduces an undesirable competitive situation between carriers operating their own aircraft and those whose equipment has been bailed to them.
- **Under the program** the government would be prevented from getting an accurate cost comparison between a purely military operation and a commercial one.

J. W. Austin Accepts Northeast Presidency

New York—James W. Austin resigned last Tuesday as Capital Airlines vice president, traffic and sales, to accept the presidency of Northeast Airlines.

George E. Gardner, president of the New England based carrier for 10 years, will become board chairman of Northeast and will continue as chief executive officer of the company.

The airline's board of directors also elected Paul F. Collins, one of Northeast's founders and its present board chairman, as chairman of its advisory committee.

The new president is expected to take over about Jan. 1. "Jim Austin brings a wealth of experience to Northeast Airlines," Gardner said, "and I am delighted that he has agreed to join us in developing our expanded routes from New England to Florida."

Austin's formal election to the post requires action by stockholders, who will be asked at their March meeting to approve enlargement of the airline's board of directors. Austin then can be elected president and also board member at that time. Following the meeting, Northeast's directors will be asked to confirm Austin's, Gardner's and Collins elections to their new positions.

Majority interest in Northeast's stock resides with Floyd Odlum.

Austin, 52, joined Capital Airlines in 1946 and is presently a director of the company as well as a vice president.

In 1949 he introduced the first aircoach service in domestic scheduled service. He also spearheaded Capital's campaign promoting the Viscount.

Capital has made no decision on a replacement.

Britannia Run Slated For New York-London

London—British Overseas Airways Corp. announced last week it will begin scheduled service with the Bristol Britannia 312 turboprop transport between London and New York on Dec. 19.

Initially, the transatlantic Britannia service will be operated on a once-weekly basis.

Schedule will be supplemented by more Britannia flights as additional aircraft are delivered by Bristol until late next year when the turboprops will handle all BOAC's transatlantic flights (AW Jan. 21, p. 38). The new BOAC service will mark the first time turbine aircraft have been operated in scheduled service on transatlantic routes.

Progress with TITANIUM

New Titanium alloys

developed by Mallory-Sharon for the missile age

Two remarkable titanium alloys developed by Mallory-Sharon's Research Laboratory further extend the usefulness of the metal in hot environments. This development promises more and more applications in rockets and missiles for titanium—strongest metal per pound of weight in its temperature range.

Commercial introduction of these new alloys culminates research and development over a two year period. In the intensive evaluation of both laboratory and production ingots, thousands of individual tests were made and analyzed. The results:

The first new alloy (MST 821) is a weldable sheet and bar material which offers strengths equivalent to similar titanium alloys—*at temperatures two hundred degrees higher.* This exceptional advantage is maintained in the range of 400 to 1000 degrees F.

The second new alloy (MST 2.5Al-16V) offers remarkable ease of fabrication for a high strength material. Sheet metal parts can be readily formed while the alloy is relatively soft, then can be heat-treated to high strengths. Heat treatment *more than triples* the strength level of this alloy.

As titanium's future in our air defense grows, it is likewise proving its economic advantages in new industrial applications. Let Mallory-Sharon, technical leader in titanium, help you *design ahead* with this new metal.

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KAI TAK's new runway, now under construction (center of picture), points southeast into Lyemun Pass. At left is present airport with two runways, one parallel to the new one. At extreme right, part of 1,200-ft. Mt. Butler is visible. Two airliners have crashed into Mt. Butler with fatal results, one in 1949 and one in 1951. In foreground are 286-ft.-high apartment buildings, soon to be razed in airport improvement program. Between buildings and new runway is section of Kowloon Hills foothills, already lowered 150 ft. for clearer approach from northwest.

Hong Kong Improves Airport Approaches

Hong Kong—Hill-encircled Kai Tak Airport, site of four major commercial air crashes, is being improved for the jet age under an $18.3 million program. Work includes building a new runway into the harbor, leveling of hills and other approach obstructions, installation of modern landing aids, and construction of new terminal and maintenance facilities.

The present airport has been the subject of criticism for some time. The unofficial Hong Kong Guide calls it "one of the worst in the world." A government public relations booklet describes it as "one of Hong Kong's biggest headaches . . . admittedly inadequate." This colony's sole civil airport has been called a supreme test of airmanship. As an American airline pilot put it: "There's just no room for error. If you're wrong, you're dead wrong."

The same sheltering hills and broken spurs that make Hong Kong a fine natural harbor also pocket Kai Tak Airport and make navigation to and from its short Japanese-built runways notoriously difficult. The approach gradient is roughly 1 in 18. The three permissible landings call for clearing 1,500 ft. wide Lyemun Pass, with hills 1,600 ft. high to port and 600 ft. high to starboard on bearing 31; making a 60-deg. turn over 150-ft. high Kowloon Hills before landing on bearing 13, or risking a pile-up into the administration buildings on foreshortened bearing 07.

Takeoffs are limited to runways 25 or 13, which again calls for a 60-deg. climbing turn.

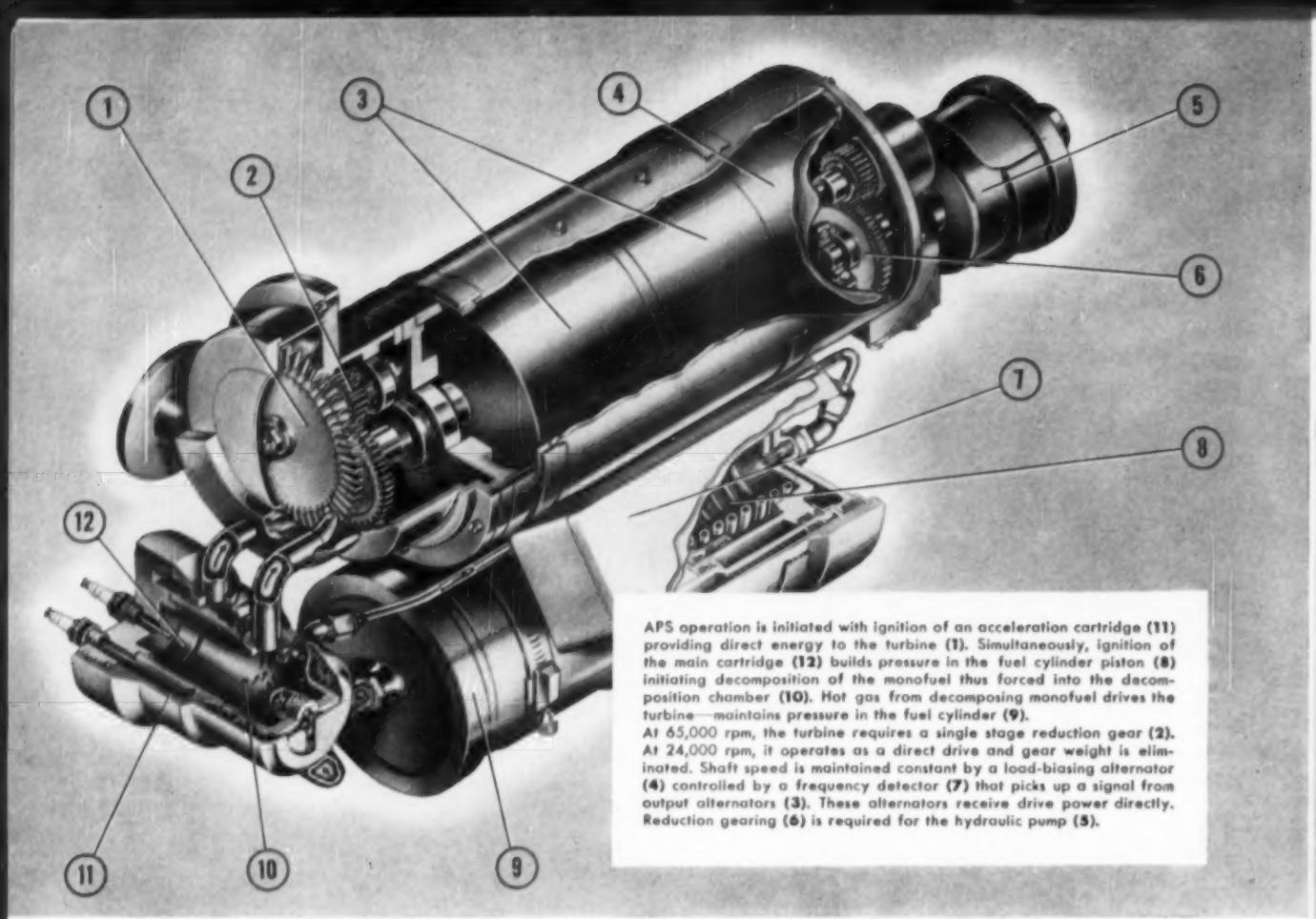
Both runways are dead-end. Predominantly easterly winds build up cloud and fog belts which make for poor visibility, particularly from February to May.

The airport closes at night, with weather minimums set at 2 mi. visibility and 500 ft. cloud base.

Civil Aviation Director M. J. Muspratt-Williams' claim that Kai Tak has the "finest safety record in the world" is questionable. Between December, 1948, and April, 1951, four major commercial transport crashes—two in virtually the identical spot on Mt. Butler, port side of the Lyemun Pass approach—took 100 lives. Sixteen scheduled airlines accounted for 22,346 air movements and 187,966 passengers through Kai Tak in 1956.

To eliminate hazards, to increase tourist revenue and to insure that Hong Kong will retain its place in the coming commercial jet age as the focal point of air routes in the Western Pacific, the government let out in January, 1955, the first $16.125 million stage of what will ultimately be the largest single civil engineering contract in its history. Result is expected to be an 8,340 by 200 ft. runway with parallel taxiway stretching into Kowloon Harbor and a modern airport capable of taking the largest jet airliners so far designed. The new runway is scheduled to be in operation by August, 1958. Then in stage two the terminal, maintenance and administration areas will be constructed on the site of the current runways and should be in operation a year later.

The psychological effect on pilots is expected to be considerable. New approach gradients will be 1 in 40 for the curved northwest approach over the Kowloon mainland and 1 in 50 for the straight southeast approach over Lyemun Pass and Kowloon Harbor. Landing from the northwest, pilots will be able to let down to 500 ft. over the sea and enter a visual approach funnel requiring only a 40-deg. turn into a 3,000-ft. straight approach to the touchdown threshold. Centerline of the curve (5,000 ft. radius) is designed to conform to a rate-1 turn of an aircraft flying at 160 kt. Landings from the southeast over Lyemun will be standard ICAO instrument-approach funnel. Presently being installed are long-range surveillance radar for aircraft separation at 300 mi. range and initial descent, and GCA medium-range surveillance and precision-approach radar to be used from 50 mi. Beacon lights will provide for break-



APS operation is initiated with ignition of an acceleration cartridge (11) providing direct energy to the turbine (1). Simultaneously, ignition of the main cartridge (12) builds pressure in the fuel cylinder piston (8) initiating decomposition of the monofuel thus forced into the decomposition chamber (10). Hot gas from decomposing monofuel drives the turbine—maintains pressure in the fuel cylinder (9).
At 65,000 rpm, the turbine requires a single stage reduction gear (2). At 24,000 rpm, it operates as a direct drive and gear weight is eliminated. Shaft speed is maintained constant by a load-biasing alternator (4) controlled by a frequency detector (7) that picks up a signal from output alternators (3). These alternators receive drive power directly. Reduction gearing (6) is required for the hydraulic pump (5).

THIS CUTAWAY SHOWS HOW . . .

Design Simplicity of Missile Accessory Power System Contributes to Light Weight and High Reliability

Completely self-contained, General Electric's new accessory power system features steady-state monofuel decomposition, reduced complexity, simplified operation, and a high degree of reliability.

BOOTSTRAP FUEL DELIVERY reduces system weight and complexity by eliminating need for fuel pumps, pressurized air or nitrogen bottles, and similar equipment. Within the fuel storage cylinder, a step piston pressurizes the monofuel to provide a constant flow to the decomposition chamber.

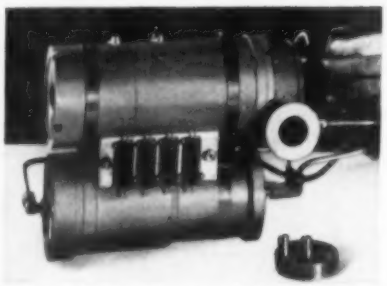
TORQUE MODULATION, accomplished by a load biasing alternator that compensates for changes in load demand, eliminates valve regulation of fuel or hot gas flow—offers precisely controlled speed.

The model illustrated—rated at 4.5 gpm, 2200 psi hydraulic power, 1 kva of 400 cps and .1 kva of 2400 cps alternating current—provides frequency control within ±1 percent and voltage control within ±5 percent without the added weight of a regulator.

DESIGN FLEXIBILITY, highlighted by an easily modified fuel capacity and a compact arrangement of easily interchanged hydraulic and electric components, permits ready adaptability to a wide range of outputs and duty cycles—minimizes size, weight, and complexity of reduction gears.

For more information on how this modular system can fit your application, mail the coupon at right or contact your General Electric Aviation and Defense Industries Sales Office.

Manufactured by General Electric's Aircraft Accessory Turbine Department, Lynn, Massachusetts.



Thirteen inches long, ten inches high, five inches wide, thirty pounds including fuel, APS reaches rated output in one-half second.

Progress Is Our Most Important Product

GENERAL ELECTRIC

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Schenectady 5, N. Y.

Please send me bulletin GEA-6672 containing detailed information on General Electric Accessory Power Systems.
☐ **immediate project** ☐ **reference only**

NAME.....

POSITION.....

COMPANY.....

CITY..... **ZONE**..... **STATE**.....

Old, New Airports Compared

PRESENT KAI TAK	NEW KAI TAK
Gross Weight	
115,000 lb. with conventional landing gear	400,000 lb. of any type aircraft now projected
Heaviest Class Aircraft	
DC-6B, Constellation L-749	Boeing 707, Douglas DC-8
Operational	
Daylight only	24-hr.
Weather Minimums	
2 mi. visibility, 500 ft. cloud base	Probably better due to improved approaches, airport lighting, radio aids
Peak Capacity	
15 to 20 aircraft movements per hour	Estimated 32 aircraft movements per hour.
Ticket Sales	
Estimated about $8 million and 50,000 passengers annually	Expected to be about $10.4 million and 65,000 passengers by 1959

away from the Lyemun approach at 500 ft. minimum altitude with highest ground in the vicinity being only 400 ft. Breakaway from the western mainland approach is set at 500 ft. minimum over the open sea.

In lowering the Kowloon Hills by 150 ft., the 2,684,000 cu. yd. excavated are being used as fill in the higher levels of the reclamation. New apartments will have to be built to compensate the owners for the scheduled razing of three recently-constructed, 10-story apartment buildings which jut 286 ft. into the path of approaching aircraft. And, to level the 109-ft. Sacred Hill of the Sung, which stood on the landward end of the proposed new runway, the contractors had first to remove a 30-ton block from the center of the 500-ton hill and set it up in an especially built park to propitiate the memory of Ti Ping, last king of the Sung dynasty.

Engineers report that the reclamation of some 162 acres, the dredging of about 10 million cu. yd., and the construction of some 5,400 yd. of sea wall necessary for the runway and parallel taxiway was slowed up by the unexpected appearance of highly abrasive sand. For the job, two bucket dredges were towed to Hong Kong from the south of France. Average dredging depth was about 34 ft. below Principal Datum (low water spring tide) but reached a maximum of 48 ft.

The runway, when completed, will provide 7,200 ft. for curved landings from the northwest, 8,080 ft. for straight landings from the southeast and the full 8,340 ft. for takeoffs in either direction..

As most flights through Hong Kong are expected to use Kai Tak for short transit stops, tentative apron plans call for an inner row of 180-deg. turn stands for 12 aircraft of any size and an outer row of through stands for eight planes. Twenty acres have been set aside for buildings, car parks, etc., in the terminal area.

Deferred Freight Rates Proposed by Examiner

Washington—Continuation of existing rates for deferred airfreight for an indefinite period has been recommended by Civil Aeronautics Board examiner Herbert K. Bryan.

Existing minimum rates authorized for deferred airfreight moving eastbound is 55% of the regular airfreight rate; for deferred freight moving in all other directions, it is 65% of the regular freight rate. The examiner also recommended that:

- **Present existing** release time: two full days on shipments under 2,100 mi. and three full days on shipments of 2,100 mi. or more, be continued.
- **Carriers should** be authorized to provide combination regular and deferred airfreight service subject to the condition that the shipper be advised that the shipment does not become deferred airfreight service until it arrives at the point where it actually enters such service. The shipment would then enter the service on a space available basis and the time of release would be computed from the time it enters the service.
- **Carriers should permit shippers** or consignees to withdraw freight from deferred airfreight service upon the payment of the difference in the rate between deferred and regular freight plus a premium to cover the increased cost of handling.
- **Carriers should** not be required to give notice of any unusual delay in the movement of a deferred airfreight shipment.

The CAB, in April 1956, authorized deferred airfreight rates for an experimental period of one year. The current proceeding was held to determine if the rates should be extended and what modifications should be made to the original order if any.

Slick Asks to Suspend Some Cargo Service

Washington—Slick Airways has asked to suspend all-cargo air freight service between St. Louis, Kansas City, Oklahoma City, Dallas-Fort Worth, San Antonio and Houston beginning next Monday.

D. W. Rentzel, Slick Airways board chairman, said increasing operational costs and uneconomical aircraft forced the air cargo line to ask the Civil Aeronautics Board for permission to suspend the service between those points. He added the suspension would be of a temporary nature until the airline acquires new modern aircraft which would be much more economical to operate.

Slick cannot continue to operate the schedules serving those points with uneconomical aircraft, Renzel said. He said Slick's new fleet of aircraft, mostly ships of the DC-6 type that are larger and cost less per mile to operate, is scheduled for delivery late next year. At this time, Rentzel said, he hopes service can be reinstated.

Rentzel said service to other points on Slick's coast-to-coast network will not be affected. This includes service to Boston, Hartford, New York, Detroit, Dayton, Cleveland, Indianapolis, Chicago, Philadelphia, Wichita, Los Angeles, San Francisco, Baltimore and San Diego.

Aeroflot May Begin Service To London With Tu-104

London—Aeroflot, the Russian state airline, may open service on the 1,500-mile route between London and Moscow with the Tu-104 jet airliners.

This was stated here last week by Marshal Zhigarev, head of Aeroflot, who arrived in London to discuss possible establishment of such a route with British authorities.

He suggested that turboprop aircraft such as the Ilyushin 18 or Antonov 10 also might be used on the route.

The X-17 is built by Lockheed's MISSILE SYSTEMS DIVISION—now engaged in advanced research-and-development projects involving missiles, rocketry, electronics, nuclear propulsion and outer space investigations.

FOR ALMOST TWO YEARS THE USAF/LOCKHEED X–17 MISSILE HAS BEEN GATHERING DATA ON THE RE–ENTRY OF BALLISTIC MISSILES INTO THE EARTH'S ATMOSPHERE. DURING THESE REPEATED TEST FIRINGS THE X–17 ESTABLISHED THE IMPRESSIVE RELIABILITY RECORD OF HAVING FLOWN SUCCESSFULLY IN 92% OF ALL LAUNCHES.

LOCKHEED *means leadership*

BALLISTIC MISSILE RESEARCH & DEVELOPMENT • ROCKETRY • WEAPON SYSTEMS MANAGEMENT • NUCLEAR-POWERED FLIGHT • ADVANCED ELECTRONICS • ANTI-SUBMARINE PATROL AIRCRAFT • LONG RANGE EARLY-WARNING RADAR CONSTELLATIONS • JET FIGHTERS • JET TRAINERS • COMMERCIAL & MILITARY PROP-JETS • LUXURY LINERS

Airline Traffic—3rd Quarter 1957

	Revenue Passengers	Revenue Passenger Miles (000)	Load Factor	U. S. Mail	Express	Freight	Total Revenue Ton-Miles	Per Cent Revenue to Available Ton-Miles
DOMESTIC TRUNK								
American	1,962,888	1,375,677	66 8	4,558,870	2,275,623	21,720,067	160,819,896	58 2
Braniff	505,222	224,595	58 7	727,575	358,405	398,110	24,055,421	47 1
Capital	1,074,724	410,168	58 4	1,394,370	683,198	1,341,628	42,814,818	47 3
Continental	231,491	111,621	56 6	288,673	148,659	448,207	11,602,058	45 9
Delta	860,508	322,085	58 3	951,251	736,060	2,384,038	35,024,930	45 6
Eastern	1,930,600	1,027,572	60 00	2,528,401	1,357,115	3,821,312	106,644,877	49 79
National†	318,678	198,460	57 4	688,602	137,873	1,294,525	21,402,678	50 5
Northeast	270,445	78,792	52 4	99,256	121,032	185,403	7,905,557	44 4
Northwest	401,010	290,893	63 4	1,070,147	634,471	2,527,660	32,181,999	54 4
Trans World	1,273,353	1,115,037	68 4	2,772,657	1,833,192	6,493,698	117,856,323	59 6
United	1,745,449	1,378,661	68 7	6,870,948	2,456,124	15,417,697	157,176,573	58 2
Western	385,253	197,167	66 5	706,604	280,560	794,156	20,688,107	57 2
INTERNATIONAL								
American	37,931	9,673	63 0	42,727	58,250	901,480	3,876,916	65 9
Braniff	13,033	26,951	55 9	51,615	.....	229,824	3,214,110	49 8
Caribbean-Atlantic	56,360	4,039	56 30	3,971	.....	9,654	436,685	61 17
Delta	18,376	22,052	65 1	20,462	.....	129,881	2,667,254	56 3
Eastern	95,843	126,900	67 37	210,580	.....	330,533	13,253,612	61 20
National†	.....	.....	.....	.....	.....	.....	.....	.....
Northwest	73,290	81,795	64 5	3,715,516	6,007	1,816,027	13,375,956	.....
Pan American								
Alaska	26,383	28,751	67 4	126,829	.....	797,101	3,872,154	56 5
Atlantic	362,813	475,793	68 7	2,208,242	.....	6,563,448	59,221,062	63 0
Latin America	344,031	381,447	70 4	1,108,480	.....	13,021,474	50,030,895	66 1
Pacific	90,206	310,545	78 8	2,645,430	.....	4,500,708	38,922,728	69 7
Panagra	34,502	44,984	59 1	179,351	.....	1,199,107	6,209,148	58 5
Trans World	99,812	268,584	66 2	2,298,814	.....	2,177,519	32,287,532	64 3
United	35,687	88,658	77 7	301,587	.....	204,342	9,532,436	71 9
LOCAL								
Allegheny	160,007	23,162	49 3	25,741	50,218	51,925	2,339,668	46 0
Bonanza	40,694	8,657	44 5	10,877	6,744	19,285	868,420	42 7
Central	34,610	6,872	36 6	12,384	7,479	25,550	704,062	32 3
Frontier	64,243	11,192	57 9	46,418	22,913	211,731	1,889,019	68 5
Lake Central	44,239	6,946	36 4	8,700	47,878	.....	720,903	39 6
Mohawk*	.....	.....	.....	.....	.....	.....	.....	.....
North Central	191,746	31,744	48 5	66,903	106,199	.....	3,224,089	49 0
Ozark	113,377	18,775	43 0	34,278	81,575	54,828	1,935,499	45 0
Piedmont	111,416	23,481	57 2	40,210	29,734	47,891	2,367,647	56 6
Southern	55,449	10,153	39 2	26,790	36,119	.....	1,035,692	38 7
Southwest	96,895	20,334	59 0	25,395	13,710	22,389	2,002,238	56 7
Trans Texas	64,233	14,993	40 0	39,316	24,089	77,618	1,523,998	40 4
West Coast	74,496	12,948	52 51	13,171	7,379	19,374	1,232,218	49 58
HAWAIIAN								
Hawaiian	133,750	20,502	61 6	10,200	.....	389,500	2,048,178	56 0
Trans Pacific	58,329	9,900	60 6	3,734	.....	37,673	784,657	60 0
CARGO LINES								
Aerovias Sud Americana	.....	.....	.....	.....	.....	2,147,058	2,147,058	87 2
Flying Tiger	38,285	167,688	99 9	85,070	69,071	22,256,318	39,539,436	55 2
Riddle*	.....	.....	.....	.....	.....	.....	.....	.....
Seaboard & Western	27,859	107,903	100 00	.....	.....	3,938,185	14,738,528	77 6
Slick	18,075	100,313	98 34	203,260	176,793	11,690,210	22,102,011	85 52
HELICOPTER								
Chicago Helicopter	21,169	235	35 1	6,608	.....	.....	35,109	.....
Los Angeles Airways	9,384	332	58 76	8,642	.....	4,918	45,897	65 68
New York Airways	21,941	404	49 7	5,478‡	2,637	1,001	48,765	45 6
ALASKA								
Alaska Airlines	6,991	[illegible],180	29 0	59,890	.....	499,964	944,180	41 4
Alaska Coastal	19,230	1,665	66 7	14,797	.....	15,078	199,262	66 3
Cordova*	.....	.....	.....	.....	.....	.....	.....	.....
Ellis	23,890	1,266	58 3	6,292	.....	10,921	145,567	67 6
Pacific Northern	38,479	39,741	62 7	297,893	.....	899,561	5,497,658	68 0

* Not Available. † System figure. ‡ Mail Transferred in Bulk.
Compiled by AVIATION WEEK from Airline Reports to the Civil Aeronautics Board.

SHORTLINES

▶ **Capital Airlines** is offering "Weekend at the Waldorf" package tours for the fifth consecutive year. The airline, in connection with the Waldorf-Astoria Hotel, flies the passenger to New York from any point on its system, installs him at the Waldorf and conducts tours of the city.

▶ **Flight Engineers'** International Assn., AFL-CIO, has added three new West Coast chapters. They are: Flying Tiger (FTL); Western (WES); California Eastern (CES) chapters.

▶ **Lufthansa German Airlines** has added its first all-cargo service to its New York-Frankfurt route. The twice-a-week service is scheduled to leave New York's International Airport on Tuesdays and Fridays, with westbound flights scheduled to leave Frankfurt on Thursdays and Sundays.

▶ **Mohawk Airlines** established a company record in November by carrying 35,827 passengers a total of 6,691,234 revenue passenger-miles. Mohawk also carried 161,027 lb. of express and 167,393 lb. of freight during the month. The airline has designated its newly-modified Convair aircraft the "Cosmopolitan."

▶ **Seaboard & Western Airlines** has reported its nine months financial figures ending Sept. 30. The figures, adjusted on the basis of shares outstanding as of Sept. 30, are: gross revenues, $17,195,880; net after taxes, $486,024; net income per share, 48¢.

▶ **Trans-Canada Air Lines** will increase its Vickers Viscount service between New York and Montreal from seven to eight flights daily on Jan. 2. On Feb. 1, a ninth flight will be added on the New-York-Montreal and New York-Toronto routes. From May 1 through October, a 10th flight will be added on both routes. Also beginning Jan. 2, TCA will add a second Viscount flight to its New York-Ottawa service. On Mar. 1, the airline will increase from five to six the number of daily flights on its Chicago-Toronto and on May 1 and June 1, a seventh and eighth flight respectively will be added to this particular schedule.

▶ **United Air Lines** flew 348,109,000 revenue passenger-miles in November to set a new company record. The airline also flew 2,389,000 ton-miles of air mail (including first class), 4,625,000 ton-miles of freight and 827,000 ton-miles of express during the November time period.

AIRLINE OBSERVER

▶ Final decision in the General Passenger Fare Investigation may not be made until next fall. However, Civil Aeronautics Board can grant an interim fare increase to domestic carriers at any time if the Board deems such a move necessary. Decision in the suspended passenger fare investigation disapproving a 6% fare increase (AW Oct. 7, p. 38) was based on airline operating figures for May before the present profit squeeze became entirely evident. In view of rising costs, coupled with a dip in passenger traffic during the past two months, the Board could feasibly review its earlier decision and grant an emergency fare increase pending the outcome of the General Passenger Fare Investigation.

▶ **Test schedule for Boeing 707 jet transports calls for first aircraft to fly late this month and undergo Boeing flight testing until mid-February. The turbojet will then be grounded to be prepared for Civil Aeronautics Administration program scheduled to begin Mar. 1. Second airplane will fly Mar. 15 and then move into company performance tests prior to CAA functional and reliability tests. Third aircraft is due to fly on Apr. 20.**

▶ Watch for early action by the Civil Aeronautics Board in the Capital Gains Proceedings. Oral arguments began last week and most observers feel the Board will be anxious to reach a decision before Congress reconvenes next month. A Board decision may obviate the necessity of further legislative action to put the ruling into effect. The House passed the bill during its last session and the Senate is scheduled to pass on it during the forthcoming session. Some observers fear the Board will support the examiner's decision which is a watered-down version of the House Bill.

▶ **In an all-day meeting with four members of the Civil Aeronautics Board and 43 Board staff members, airlines recently presented a detailed outline of the engineering and operational problems that can be expected to accompany the introduction of turbine transports. Purpose of the unprecedented meeting was to expose Board members to a "complete spectrum" of the issues airlines will be forced to cope with in the jet age. Under the direction of the Air Transport Assn., five airlines—American, Eastern, Pan American, TWA and United—made the presentation.**

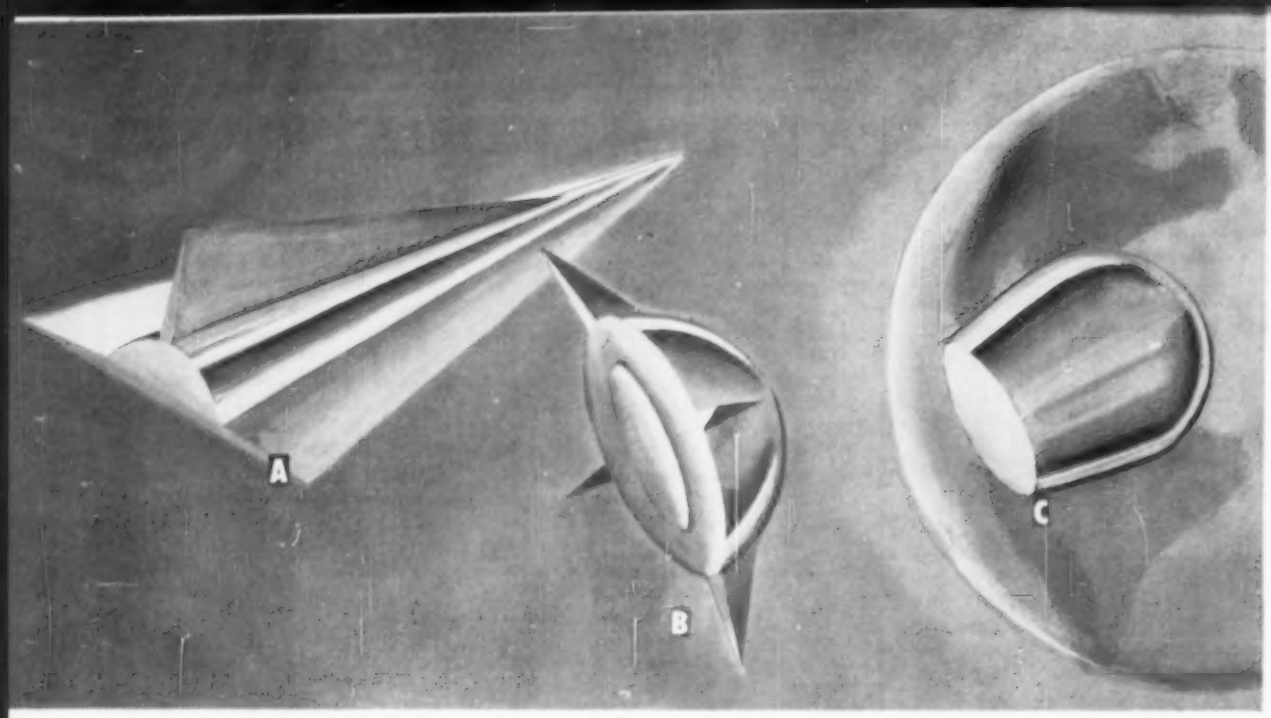
▶ Long-range forecasters are predicting airlines will face most severe flying conditions during the next few months than any experienced in recent history. Observers note correlation of unusual displays of sunspots to bad weather, say 1958 is the transitional year in the 33-year cycle of warm to cold weather change and will produce a large number of severe freak storms.

▶ **Port of New York Authority, which has banned all jet transports not meeting its noise level requirements, carefully skirted the jet future in promotional literature describing new building and terminal city development at Idlewild International Airport. Recognizable aircraft illustrated in the agency's brochure were piston type and nowhere in the copy was the word "jet" used. In renderings by airlines of their proposed terminals at Idlewild, turbine aircraft are very much in evidence.**

▶ Fairchild Friendship F-27 turboprop transport sales now total 89 in firm orders and short term options. LAV—Linea Aeropostal Venezolana—is the latest purchaser of the F-27 with an order for six of the 40-passenger turboprops.

▶ **Dallas Love Field's new terminal facilities are now scheduled to open by Jan. 15. Plagued all year by construction delays, new terminal was supposed to open after elaborate dedication ceremonies held at the end of October. Now, unfinished restaurant facilities will delay use until mid-January.**

▶ Soviet Union probably will seek permission to bring its Tu-114 turboprop transport (AW Dec. 9, p. 38) to the U.S. soil to carry its United Nations delegation home. State Department had received no official request by late last week, but Russian Embassy gave every indication that the project is under serious study. Earlier this fall, Soviets flew the delegation to the U.S. in Tu-104s (AW Sept. 2, p.40).



MANNED SPACE FLIGHT will probably begin in a winged hypersonic glider similar to vehicle A above or in a non-lifting, modified spherical craft somewhat like the three to the right, according to astronautical experts. The glider would be the most versatile machine as it could maintain altitude and change direction upon re-entry to effect a landing at any point on the earth. The non-lifting vehicles would plunge to the ground as soon as drag reduces their velocity and centrifugal lift below the orbital requirement. A completely spherical vehicle has been proposed by Krafft Ehricke as a space parachute to allow men to return to the earth from disabled space stations, gliders, etc. Vehicle D at right has fins added to stabilize the sphere and a small rocket motor to slow it to circular speed. The hemispherical vehicle B was suggested by A. J. Eggers, Jr., of the NACA as meeting the requirement for a manned re-entry craft. Vehicle C has been described by a number of scientists. The purpose of the truncated cone on the aft portion of the sphere is to make the vehicle slightly unstable so that it will wobble when it enters the atmosphere. The stagnation point on the hemispherical forebody which is heated to the highest temperature during re-entry then becomes a rather large circle spreading the heat and lowering the maximum temperature on the vehicle.

Sphere, Glider Feasible for Re-Entry

By J. S Butz, Jr.

New York—Soundness of U. S. space flight efforts for years to come may depend on the choice of a vehicle to win the second round in the struggle to control space, members of the American Rocket Society were told here recently.

Goal of this second round, placing a man in orbit around the earth and bringing him back safely to the ground, has tremendous scientific and propaganda value for the nation reaching it first regardless of the manner in which it is accomplished. Its greatest significance, according to many U. S. scientists, will be to demonstrate how well the government is laying the groundwork for future space activity.

The government's management decision will be to choose either one or both of two feasible vehicles which can be propelled by large rockets into orbit close to the earth and then return intact within a few days. They are:

• **Winged hypersonic glider** that can re-enter the atmosphere and use its lift to remain in the upper air and slow down before it returns to the surface.

• **Spherical** or modified spherical vehicle which develops no lift but can safely plunge back into the atmosphere from space if its flight path is correct.

The spherical craft would take a much shorter time to develop than the hypersonic glider—one to two years against five for the glider by the most optimistic estimate—and put the U. S. in a better position to send the first man into space.

Priority Preferences

Yet many astronautical and aeronautical experts who are very anxious to repair the damage U. S. prestige has suffered in the last two months feel that spherical craft should have second priority and that nothing should interfere with the development of the hypersonic glider. In their opinion the spherical, non-lifting craft would be a stopgap measure if developed alone and should occupy only a small part of our total development capacity.

This opinion arises from the belief that the hypersonic glider in its final form will be a vital part of any large scale movement into space, and that the sphere will never be more than a space parachute to bring men back from disabled gliders and space stations. The glider will be safer and more controllable than the non-lifting craft and it will be able to land in any given location on the earth's surface.

The re-entry from orbit glider will be as valuable in another way which is fully as important as the space aspect. It will require that great effort be made to answer the aerodynamic problems of winged vehicles (heating, stability, control, drag, etc.) up to about 18,000 mph. Hypersonic bombers, fighters, rocket transport planes, etc., will all become possible as soon as these problems are solved.

Any air force that has sole possession of such craft would border on the invincible, hence the scientific opinion that the hypersonic glider should receive a maximum engineering effort.

Another facet of scientific thought regarding placing a man in space is the doubt that large rocket systems will be reliable enough within the next five years to transport human beings. The risks involved in re-entering the atmosphere in a spherical capsule plus the dangers of riding rockets into space

would give man small prospect of a successful journey for several years to come, in the opinion of many scientists.

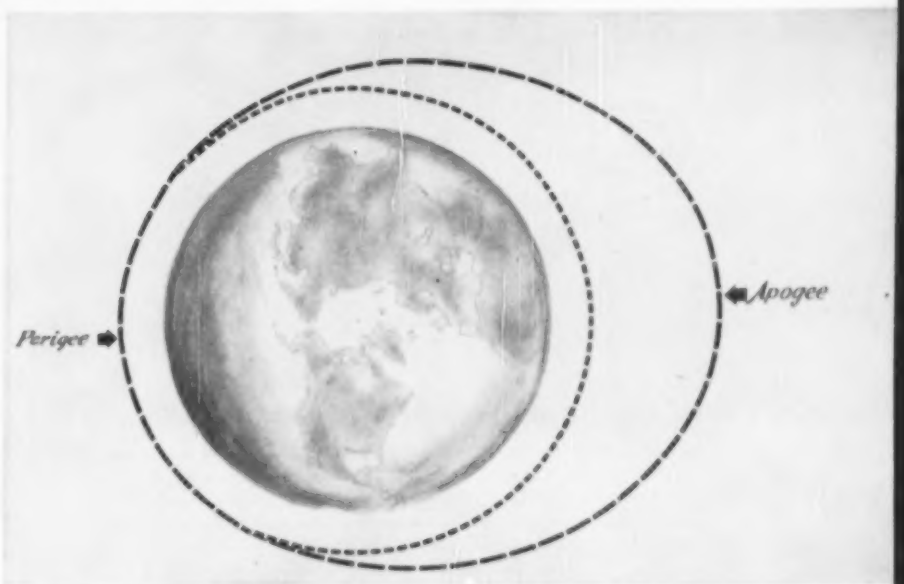
Pressure to send the first man into space at all costs and help the U. S. on the propaganda front could force governmental delay in attempting to create a hypersonic glider in the shortest possible time. If this comes about the race to win the second round then becomes not so much a question of whether the U. S. can develop large rockets and a re-entry sphere before the Russians, but rather will the U. S. program be doomed to running second to the Russians again because the U. S. demanded too much reliability from its systems.

Russian officials might consider giving a green light to their space flight volunteers at a much earlier period in a development program than ours would and send their men into space in a manner the U. S. would judge unsafe. This almost indeterminate factor, of course, affects the outcome of many of the technological races we are in with the Russians.

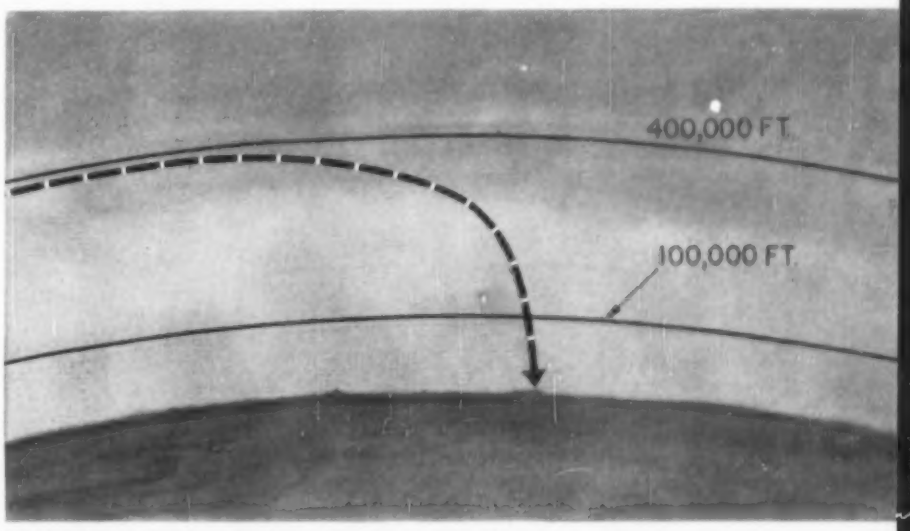
Two Best Choices

Regardless of the policy decision as to the best space flight program, general scientific opinion holds that either the hypersonic glider or the spherical vehicle will carry the first man into space and bring him back.

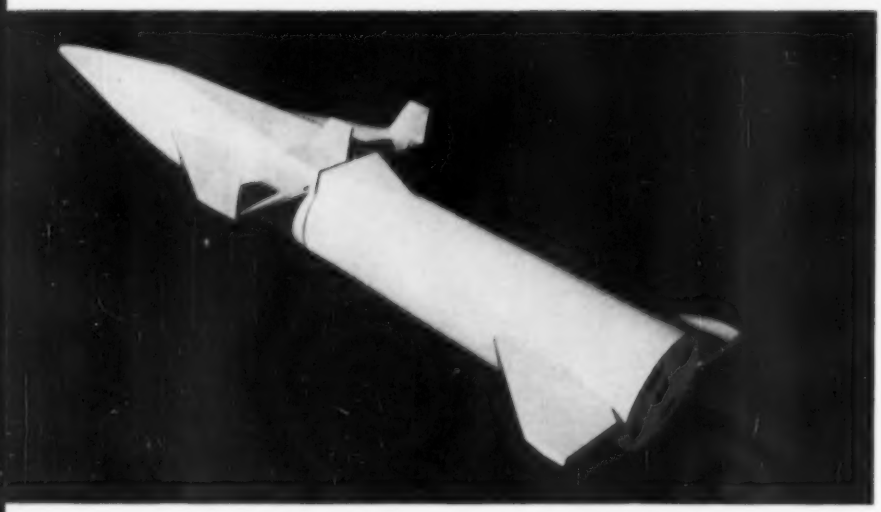
Several types of non-lifting, orbital and re-entry vehicles of general spherical shape have been proposed over the last few years. Krafft Ehricke of Convair and several scientists of the National Advisory Committee for Aeronautics including A. J. Eggers, Jr., are among those who have written on the subject. Such vehicles would be invalu-



CHANCES ARE HIGH that a manned satellite would enter an elliptical rather than a circular orbit as it is sent into space. Theory shows that a non-lifting vehicle must make its re-entry at a very low angle and at nearly circular velocity to keep decelerations and temperatures below the critical point. The elliptical orbit would eventually decay into the necessary circular path as it gradually decelerates. Since this might take months, a manned satellite would be equipped with retarding rockets to fire as it passed near and through the perigee. This would shorten the time needed to create the circular orbit and require a minimum of guidance and propulsion weight.



FINAL PHASE of the non-lifting satellite's return to Earth is a sudden plunge during which deceleration will not exceed 7Gs if the plunge begins at the correct circular velocity and at a low angle to the horizontal. Circular velocity required to orbit increases as the satellite moves toward the Earth; the velocity increase is furnished by the potential energy released as altitude is lost. Once atmospheric drag decelerates the sphere faster than potential energy is released, the plunge begins. The more lightly loaded spheres will start their plunge at the higher altitudes and experience a lower deceleration and temperature rise than the heavy spheres. At approximately 30,000 ft. a parachute would be deployed to lower the sphere safely to the ground.



MODEL of one of the hypersonic gliders proposed by Krafft Ehricke is shown mounted on a two-stage booster. The second stage is placed under the glider to keep the total length of the rocket system relatively low. The glider would be powered to serve as a third stage on the trip into space. A fuel reserve would probably be maintained so the glider could enter the most favorable orbit for making a re-entry.

able as unmanned instrumented satellites which could return visual evidence of the effects of space on materials and biological specimens. The specimens would presumably have to be retracted into the sphere to keep the friction and high temperatures of re-entry from erasing evidence of the trip into space.

The deceleration, air loads, temperature, etc., that these spherical vehicles experience as they come back to earth are within human as well as present structural capacity, according to the men studying the problem. By providing them with the proper internal environment the spheres could carry men. The highest decelerative loading upon re-entry can be low as 7Gs and this would last less than 2 min. Maximum temperature on the surface of the sphere could be less than 2,500F. These critical temperatures and decelerations are primarily a function of three factors:

- **Making re-entry** at a low angle with the horizontal.
- **Maintaining proper** circular velocity at each altitude on the way down.
- **Low sphere loading** (sphere weight/sphere cross-sectional area).

Once the re-entry angle gets larger than 5 deg. and the satellite velocity varies much more than 300 fps. above or below the proper circular velocity, deceleration and temperature during the final plunge build rapidly to more than 30G and 5,000F.

Light sphere loading is very desirable but it does not have as great an effect on G loading and temperature as do velocity and angle of attack.

Ideal re-entry is made when a satellite travels exactly at circular velocity so that its re-entry angle will be less than one degree. Since most satellite orbits will initially be elliptical because of the extremely accurate guidance necessary to attain a circular path, the problem is to change the elliptical orbit into a circular one.

This occurs naturally once the satellite has remained aloft several days, even if the orbit is severely elliptical. The satellite experiences some drag at every point on its orbit, but drag is by far the greatest at the perigee (minimum altitude). Since the velocity reduction occurs mostly at this point, the satellite enters a new reduced energy orbit which has approximately the same perigee as the preceding orbit but a shorter apogee (maximum altitude), and the orbit becomes circular.

Loss of Altitude

Once a circular path is reached and the velocity reduction due to drag is uniform around the orbit (most scientists studying the problem assume that the air density at any altitude varies from the Earth's gravitational field in the same manner that the altitude of the satellite fluctuates), loss of altitude then becomes uniform. As altitude is lost, potential energy is transformed into kinetic energy and the velocity of the satellite increases. This energy transfer is vital because the velocity needed to stay in orbit increases as the altitude decreases.

Finally, the rate of kinetic energy loss due to drag is greater than the release of potential energy, velocity drops below the value needed for circular flight and the satellite begins its plunge. The major problem with the manned satellite is to change rapidly the initial elliptical orbit into a circular one. Tracking of the Russian Sputnik has shown that this process if left to nature can take months.

From the standpoint of guidance simplicity and propulsion economy the elliptical orbit can be made circular most easily by firing a retarding rocket at an angle tangent to the earth's surface every time the manned satellite passes through its perigee. Once the orbit becomes circular extreme care must be used in hastening the descent. If the velocity is reduced too much the satellite will begin to spiral toward the Earth and its final plunge will begin at a dangerously large angle.

Thin Outer Shell

Krafft Ehricke has predicted in his treatment of spherical satellites that a manned vehicle will have a thin outer shell of an existing high heat resistant material such as a molybdenum alloy. A layer of insulation about one inch thick would keep the skin from heating the supporting inner structure. The heat sink type of construction with its thick walls would be unsatisfactory, according to Ehricke, because the heating times would be too low. It is calculated that temperatures about 1,000F would last between 4 to 12 min. The shortness of the heating time is probably responsible more than any other factor for making the spherical manned satellite a relatively short time project.

In contrast the hypersonic re-entry glider, which can use its lift to control its flight path and avoid dangerously large decelerations in its circular return to the Earth will be subjected to severe aerodynamic heating for periods up to an hour. Even though much of the heat generated can be radiated back to the atmosphere the cooling and materials problems plus stability and control and the lift and drag problems, etc., will require a considerable extension of today's knowledge.

A major impediment in the rapid extension of design data is adequate research facilities and aircraft for the study of bodies in very high speed flight in very sparse air. The North American X-15 is a major step forward in this respect.

There seems to be considerable doubt in some industry quarters that a re-entry glider will be feasible within 10 years. The opposite view is held by other industry engineers and many government research people who feel that any company that does not become active in the field now will be left behind.

While the jump from Mach 2 or 3 to Mach 20 and better is a tremendous step, many experts indicate that the main barrier, heating, will be overcome in the near future.

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American Rocket Society:

Putting Free Radical Propulsion Into Rocket Offers Big Challenge

New York—Free radical propulsion, which on paper offers specific impulse increases from current 300 sec. to 1,000 sec., also offers formidable challenges, G. C. Szego and E. A. Mickle of General Electric Co.'s rocket section, Cincinnati, Ohio, told the American Rocket Society here.

These challenges of free radicals are met in attempting to reproduce a fleeting laboratory phenomenon full scale in workable rocket engines.

Foremost among the techniques for solution, they list cryogenics—the use of very low temperature environments—to hold the metastable radicals in check until their energy was needed.

The authors said that a team from the National Bureau of Standards, universities and industry are now at work on the problem at the Bureau of Standards, Washington, D. C. Because the work is unclassified, scientific talent from abroad is being used. The salaries of the visiting industrially-sponsored scientists are paid by their employers. The Bureau of Standards is providing equipment and supplies. In this respect a spokesman for the Bureau of Standards told AVIATION WEEK he felt that funds allocated to free radical work should be concentrated on basic research rather than on "false starts" in trying to achieve end-product hardware before anybody really knew much about the phenomena. Dr. Broida of the Bureau, pioneer in the field, has been known to express personal doubts as to whether free radicals will ever be used as rocket propulsion fuel.

Solid Fuel Ramjets

Solid fuel ramjets have been under development in this country by Experiment Inc., Continental Aviation & Engineering Corp. (AW Oct. 14, p. 123), Bureau of Mines and the National Advisory Committee for Aeronautics, according to Robert L. Wolf and James W. Mullen, Experiment Inc., Richmond, Va.

First supersonic flight of solid fuel ramjet vehicle was in January, 1952, when an Experiment Inc. test vehicle approached 2,100 fps. (nearly Mach 2), for a 12 sec. burning time.

Future uses could include self-accelerated ramjets, extreme altitude ramjets using magnesium fuel, gun-launched ramjets, anti-tank missiles and even for some phases of airbreathing intercontinental missiles. These uses would take advantage of the special attributes of solid fueled ramjets, their greater reliability and altitude capability over liquid fueled ramjets and their greater ranges, in flat trajectories, over rockets.

Calculations have shown that for short and intermediate ranges from 20-200 mi., sufficient solid propellant fuel can be stored within the ramjet combustion chamber. For longer ranges up to 1,000 mi., multiple or external solid fuel packages or high energy fuels with low burning rates will have to be developed.

Magnesium, aluminum, kerosene and a carbon fuel were compared, with the solid metallic fuels looking best from the air specific impulse standpoint and kerosene looking best from a fuel specific impulse consideration. Solid fuels were shown to often require significantly less storage space.

Fuel Sloshing

Theoretical solution of fuel sloshing modes in the tanks of liquid fuel rocket engine systems was presented in a paper by H. R. Lawrence, C. J. Wang and R. B. Reddy of the Ramo-Wooldridge Corp.

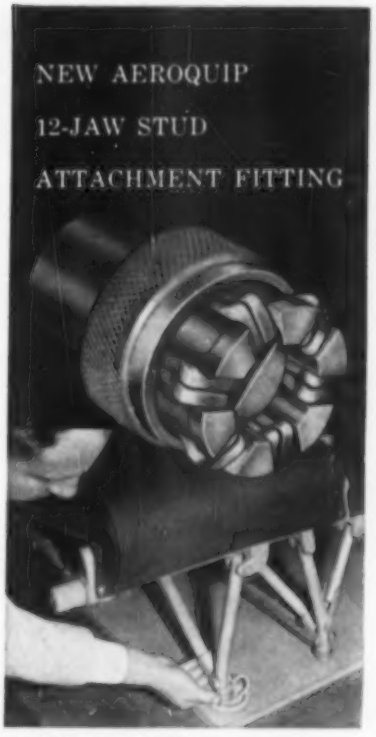
Their method was to use integral equations or variational methods to find the sloshing modes.

This contrasts with the class procedure in use since the middle of the Eighteenth Century which requires that the problem be stated in differential form and the solution found through the separation of variables technique.

The method presented by the Ramo-Wooldridge engineers is more adapted to the problem of tanks with finite dimensions and also handles tanks with baffle systems installed. Experimental verification of their results has shown that their method is applicable to a wide range of problems.

Precise knowledge of the natural frequencies of the sloshing modes of the liquids in a rocket's propellant tanks is needed for the design of two important systems in a missile:

- **Autopilot** in the missile guidance system must be able to control all motions which will be experienced during flight. The missile motions that will be induced by sloshing fuel must be pinned down completely to design the autopilot.
- **Propellant utilization** systems must have a high accuracy to insure that all of the rocket fuel and oxidizer have been mixed in the proper proportions during powered flight and that no large weight of residual fuel exists after burnout. To



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accomplish this, the fuel systems engineer must allow for sloshing to keep the propellant mixture correct for greatest accuracy.

Ramjet Fuel System

When highly reactive fuels are utilized, attention must be paid to tendency for combustion stratification if the promise of these fuels is to be realized, according to Warren Koffer and Gilbert S. Bahn, Marquardt Aircraft Co., Van Nuys, Calif.

Speaking primarily of ramjet burners, the authors said that stratified fuel distribution would impose major reductions in combustion efficiency even where there were no such problems as flameholding, flamespreading or reaction rate.

Assuming that they could use a fuel so reactive as to eliminate the need for flameholders, the authors looked forward to a ramjet fuel system which would use hypergolic fuel which would ignite spontaneously as it came out of downstream-directed orifices. They said that diminished combustion chamber pressures at high altitudes make the use of these more active fuels attractive, while the increased combustion inlet temperatures at Mach 4 and above help by making ordinary fuels more reactive.

Solid Propellant Pusher

If solid propellants could be used as substitutes for inert gas and turbopumps, lighter, more reliable liquid rockets might result. Jerome Salzman of the Solid Propellant Division, Reaction Motors Inc., proposed that solid propellants such as Imperial Chemical Industry Ltd.'s ammonium nitrate solid propellants, which use ammonium dichromate as a catalyst, be used to enter propellant tanks directly and push the propellant into the rocket thrust chamber.

Unfortunately, though this solid propellant does not form combustionable mixtures with many liquid propellants, it produces 8% solid products which can act as ignition nuclei for detonation in main propellant tanks. Also, like most solid systems, its burning rate varies widely with temperature, producing uneven pressurization in operational use.

Required Properties

Need is for low combustion temperature solid pressurization propellant whose combustion products contain no solid particles and do not react with main propellants.

In addition to his company, Reaction Motors Inc., Salzman said that the U.S. Naval Ordnance Test Station and M. W. Kellogg Co. have been working to develop this concept of using solid fuels.

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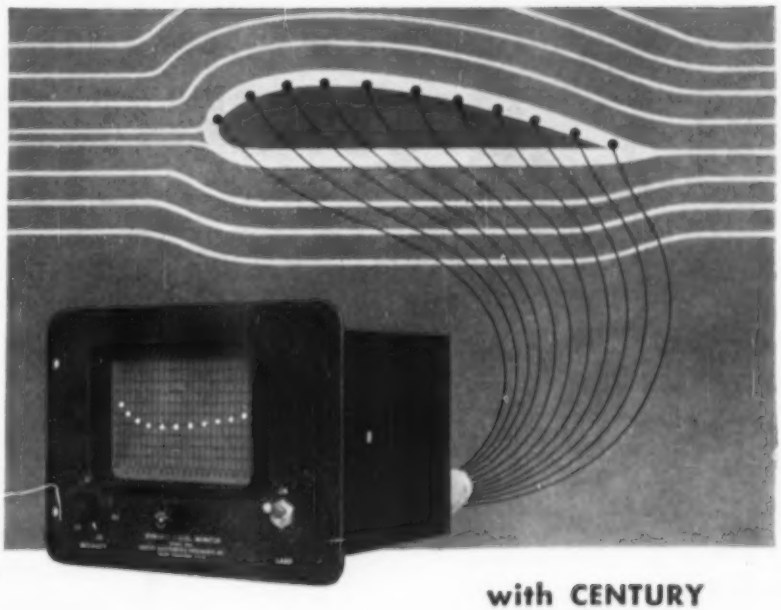

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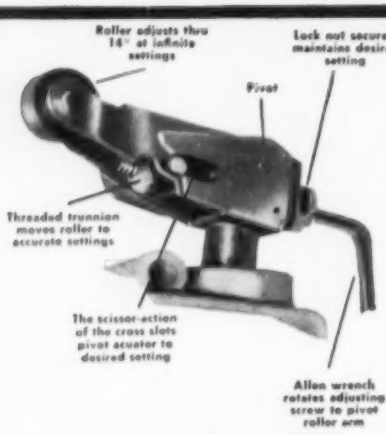
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Overtravel	281 min.
Operating force	4 lbs. +2, −0
Overtravel force	11 lbs. ±3
Dielectric strength	1000 V. R.M.S. min.
Ambient temperature range	−100° to +250° F.
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TV Camera Receivers Check Rocket Engines

Large closed circuit television system for guided missile testing has been installed by Hallamore Electronics Co., division of the Siegler Corp., at Aerojet-General Corp.'s rocket engine test facilities in Sacramento, Calif.

Thirty-six complete camera-receiver "chains" comprise Hallamore's system. Aerojet-General is using these chains in both its liquid propellant plant and solid propellant plant.

Hallamore is currently installing a similar system of 24 closed circuit television chains for the Martin Co., prime contractor on Titan intercontinental ballistic missile program at Martin's Denver plant.

A 22-chain system was recently completed by Hallamore at Army Ballistic Missile Agency in Huntsville, Ala.

Lockheed Gets Order For Polaris Facility

Lockheed Missile Systems Division has been awarded a $3 million contract for construction of development facility for Polaris ballistic missile, Navy's highest priority project.

New facility, located at division's Sunnyvale, Calif., plant, will house testing activities, engineering, planning, administrative support and Navy administration under a single roof. Building will contain approximately 153,000 sq. ft. and will have high bay crane tower with overhead handling equipment required in structural test areas.

Aerojet General Delivers Titan Production Engines

Aerojet-General Corp. recently delivered the first production-type liquid fuel rocket engine for the Air Force Titan intercontinental ballistic missile to the Martin Co's Denver Division. The Martin Co. is prime contractor for the Titan.

The engine was produced in Aerojet-General's $14 million metal parts manufacturing plant in Sacramento, Calif.

Dr. Barnes Will Head Space Research Company

Systems Corp. of America has been formed to conduct research and development in space technology, and will begin operations at 1007 Broxton Ave., Los Angeles, Calif., in January, 1958. Organization will be headed by Dr. John L. Barnes, professor of engineering at University of California at Los Angeles, who also has been affiliated with various aircraft and missile companies in the Los Angeles area.

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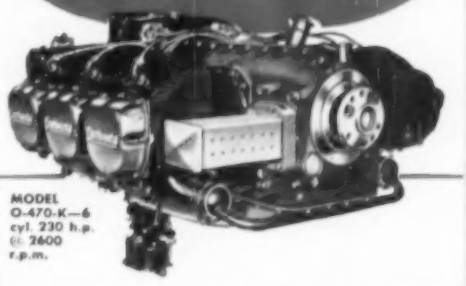

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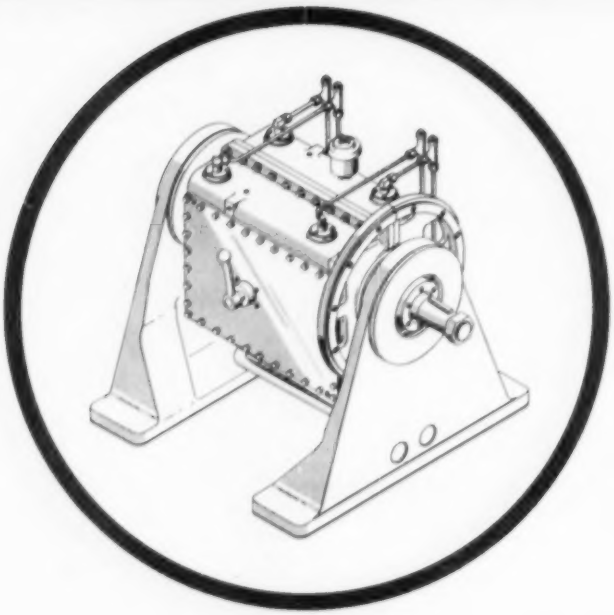

Here's a trunnion-mounted, multi-speed unit used with a dynamometer test facility for guided missile pumps. This unit has a top output speed of 60,000 RPM with a pitch line velocity in excess of 30,000 FPM or more than 340 miles per hour. Unit measures approximately 25 inches in length.

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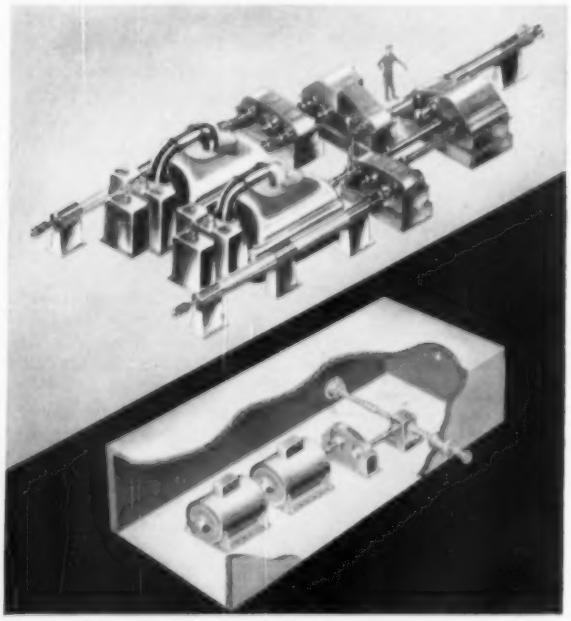

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Scientists Disagree on Man's Space Role

By George L. Christian

Philadelphia—Disagreement between human factors specialists on the one side and systems engineers on the other on the role of man in manned space flight arose here during one of the first full-dress discussions ever held on the subject in the U.S. Specific topic of debate was: How to design a control system for a manned space ship.

The human factors group, made up of such professionals as psychologists, physiologists, biophysicists and anthropologists, want to keep man awake and alert during his round trip to such destinations as the Moon or Mars. They proposed a variety of jobs for man; among them: emergency duties, observation, reconnaissance, maintenance and repair of malfunctions on the space ship and landing and taking it off.

Travel Asleep

Systems engineers prefer to put man to sleep during his voyage through outer space, and feed him intravenously if trip length requires it.

Launching, en route and landing control of the space ship would all be programmed and implemented through the use of computers and automated controls, and could probably do the job of controlling the space ship better than man. Also, by having him sleep during the trip, man could reserve his energy to perform a job that no automated machinery could do nearly so well; namely, explore his destination.

Conference was titled National Symposium on Human Factors in Systems Engineering and was sponsored jointly by the Human Factors Society of America and the Institute of Radio Engineers (Philadelphia Section) IRE Professional Group on Military Electronics. The General Electric Company was host and assisted in management.

A six-man panel, conducted as though it were a preliminary design team considering the problem of developing a control system for a manned space ship, led the symposium.

Panel chairman was Dr. John S. Brady, Support Systems Dept., Guided Missile Research Div., Ramo-Wooldridge Corp. Panel members were: Dr. D. C. Beaumariage, Radio Corporation of America, Waltham, Mass., Dr. J. C. R. Licklider, Bolt, Beranek and Newman, Inc., Cambridge, Mass.; Irwin C. Abrahams, General Electric Co., Syracuse, N. Y.; Dr. A. Heatherington, Air Research and Development Command, Baltimore, Md., and Dr. E. I. Hawthorne, Electronics Dept., University of Pennsylvania.

Mission of the symposium's vehicle is to take off from a satellite orbiting around the Earth, fly to the Moon, come into a circumlunar orbit between 50-100 mi. from the Moon (to do this the space ship must convert a 5,000 mph. descent into a 3,700 mph. horizontal velocity at the 50-100 mi. altitude, turn the ship around for rocket braking and put it through a programmed deceleration).

If descending from 100 mi. above the Moon, the space ship would take 7½ min. if it were to fall free and the velocity at impact would be 1,500 mph. With a 1G deceleration, however, the fall could be checked in approximately the last 1½ min.

Moon Takeoff

After exploration, the man would take the ship off again. During his orbiting of the Moon for the return journey, he might lock some supplies, such as empty fuel tanks, in the orbit, then are off towards the Earth and rendezvous with the space platform orbiting around the Earth.

Space Flight Problems

Two major problem areas of human space flight are complete reliability of the propulsion system and heat and G forces created during re-entry, Brig. Gen. Don Flickinger, Director of Human Factors, ARDC, told Aviation Week. Associated with the latter problem is development of an escape means for the human being in case of equipment, structural or other major failure during re-entry.

Gen. Flickinger stressed the fact that he was talking about a man orbiting the earth for a relatively short time, "6 hr. to 3-4 days," he said. He was not discussing shooting a man to the moon. "This involves still other even more complex problems," he said.

The well-publicized questions of weightlessness, effects of cosmic rays and meteor impact do not give as much concern as the first two problems, according to Gen. Flickinger. Reason is that effects of these conditions can be fairly well predicted. As he points out, the true problems of weightlessness, cosmic ray effects and meteor impact cannot be known until man orbits the earth. However, he feels that the difference between predicted conditions and actual conditions as experienced by the first space man will not be unreasonably far apart.

Still other problems to be solved are means of displaying unusual attitude of man's space ship and developing necessarily unusual means of controlling it.

The human factors group generally took the attitude, "since you have a man aboard, you might as well make use of his capabilities and use them to eliminate as much mechanism, electronic and otherwise, as his capabilities will allow . . . you have paid a high price in weight and means to assure his survival, so take advantage of his presence."

There were different shades of responsibility suggested for space man. Some thought he should act as a supra system—select between existing situations, and possibly turn back, if that appears like the desirable thing to do. Others suggested that he have an extra system role—perform any emergency procedures as they might occur. Another thought was that man should be integrated into the control loop and treated as a component of the control system. His function would be to take over from the automated control system when unprogrammable situations, such as a landing sequence, arose. All agreed that navigation was an operation well suited to automation and ill suited to man.

To these concepts, an engineer objected. The basic premise, he said, is that we will send out an unmanned space ship before a manned, and we will recover it.

Vehicle Control

Therefore, control is no problem for the human in a manned ship. His vehicle will be controlled in the same basic manner as the unmanned ship.

Immediate rebuttal took this pattern: certain basic differences between the mission and operation of the unmanned space ship make it improbable that its control means can be extrapolated to manned space ships. Example: it is unlikely that an unmanned vehicle would be required to land and take off from the Moon, whereas this would be one of the primary aims of a manned vehicle.

Also, takeoff Gs on an unmanned ship would reasonably be well beyond the capability of a man to endure.

Thirdly, environment within the space ship and its control requirements would be totally different between an unmanned and manned vehicle.

Some of the many opinions expressed by members of the panel and the audience of the symposium included one that a space ship should include these four sub-systems:

- **Pathological system** to control pressurization, heat, cold, oxygen, humidity and other factors directly related to longevity of the crew.
- **Navigational and guidance** system,

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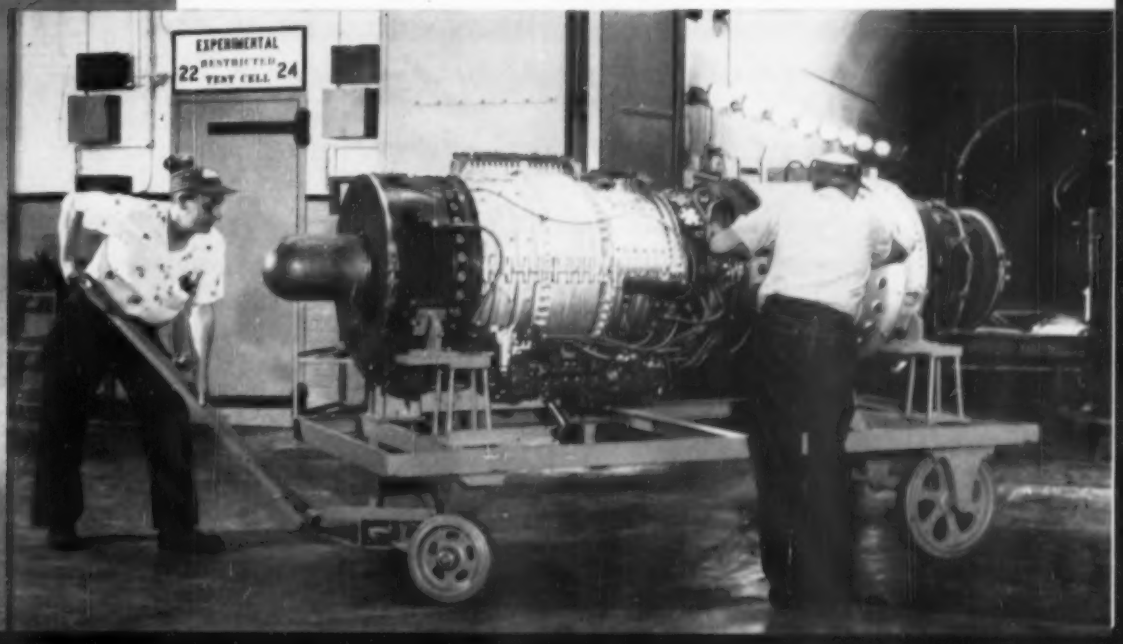

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which would be completely automatic since the precise path the vehicle must follow is known and because such a system is amenable to automation.

• **Maintenance and repair** facilities to repair malfunctions in flight.

• **Communications system** with the earth. This will be easy on a trip to the moon, very difficult on a trip to Mars, according to the scientists.

Some of the environmental variables that are totally or almost totally outside the experience of the man on earth were summarized this way:

• **Abnormal acceleration.** Very high Gs on blast off and long periods of zero G during cruise. Meeting was warned not to expect a man to do much in the way of accomplishing tasks if he is subjected to much over 2Gs during takeoff. At 4-5 Gs, he is quite incapable of doing much work.

• **Perception.** Very strong light contrasts caused by the existence of undiluted sunlight and unscattered dark will impose problems.

• **Total lack** of visual reference points of sizes with which man is familiar but seen at distances which he cannot interpret will disorient him.

• **Sheer peculiarity** of his environment—confinement, weightlessness, realization that he is further from home than he has ever been before and that he may never return, the elimination of a diurnal pattern, all these elements may influence a man's capability as a controller and have disturbing psychological effects on him.

Weightlessness alone, for a period of weeks, will be much worse than an equivalent period of completely enforced rest. Resultant enervation must be offset by old fashioned calisthenics.

Other Suggestions

Among other suggestions relative to manned space flight were:

• **Automate** all predictable elements of flight and allow man to handle the unpredictable.

• **Conditions** of weightlessness and high Gs at takeoff will no longer be a problem for a flight to the moon or further because so much experience will have been fathered prior to the flight while commuting to and from the space platform and working around it during assembly of the space ship.

• **Windows** would be inadequate for looking out of a space ship. Better solution is closed circuit, miniaturized television.

• **Eskimos** would be good space travellers since they are not accustomed to the diurnal cycle. Suggestion was made that possibly a psychiatrist should accompany them to help them adjust to their new environment. (No comment was made on who would help the psychiatrist).

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New Sciaky Counter Control

To help meet these requirements, Heintz now uses Sciaky Patented Three-Phase Resistance Welders with the new Predetermined Electronic Counter Control. This new unit provides precise control of all welder functions for absolute production consistency. All control settings are realized with extreme accuracy, and are readily reproduced at any time to duplicate previous production runs. The machine cannot deviate from its setting.

Fig. 1 Seam welding Nimonic to Nimonic on Pratt & Whitney Aircraft J-57 afterburner diffuser section.

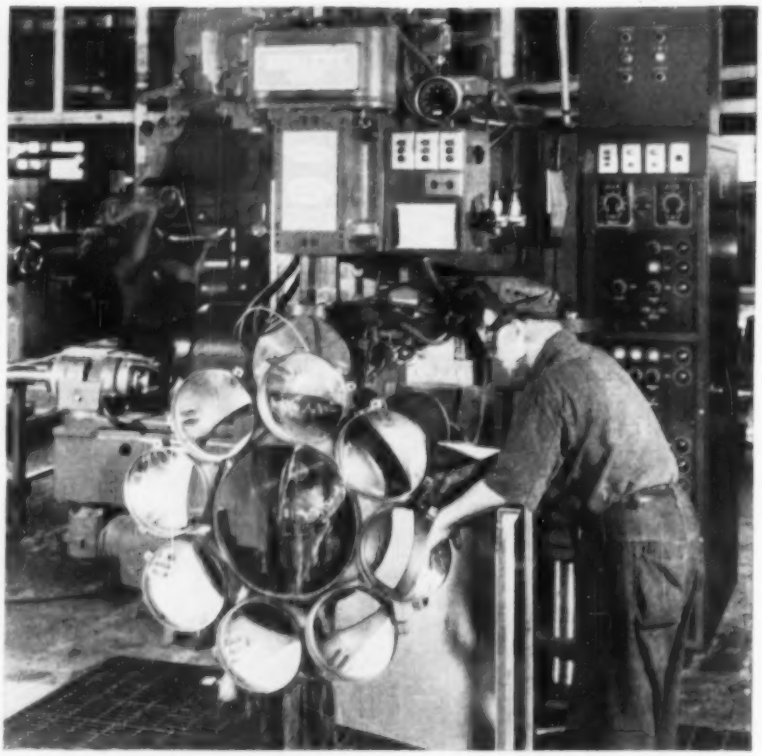

Fig. 2 Seam welding stainless to stainless on Pratt & Whitney Aircraft J-57 jet engine transition duct assembly. Note simple fixture used.

The Sciaky Predetermined Electronic Counter Weld Control is the only control of this type that has been proved in service, and the first unit of this kind has now been in use nearly two years.

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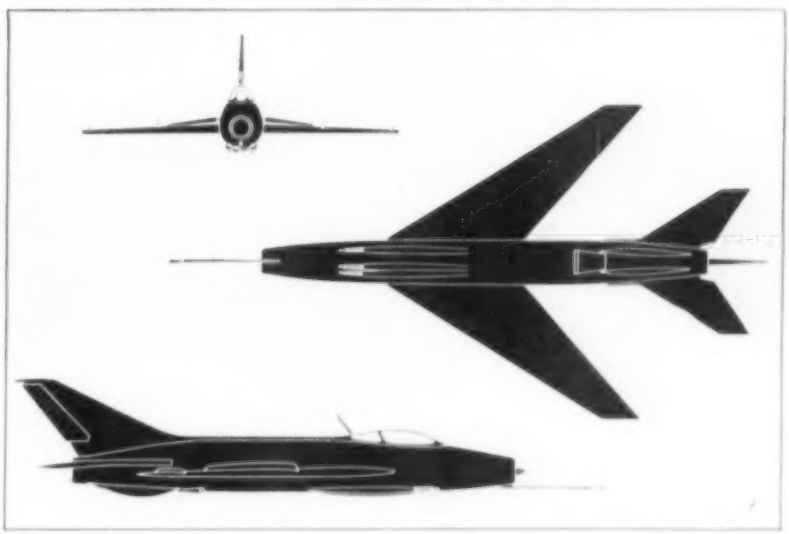
Soviet's MiG-21 Faceplate Fighter in Mach 1.5 Class

Soviet MiG-21 Faceplate fighter is a single-seat, 1,200 mph. turbojet. The high-performance, high-altitude sweptwing aircraft is a development of the MiG-19 Farmer fighter. (Farmer has two turbojets, each rated at 10,000 lb. thrust.) Faceplate's horizontal stabilizer is swept to match the wing; it is faired forward on the fuselage. Note fairing that extends from cockpit to tail, and the two fins which project from the fuselage beneath the tail. Overall span of the aircraft is 33 ft.; overall length is 50 ft. Faceplate was observed and photographed in Russia at Tushino in 1956; at that time it was designated Super Farmer by U.S. observers (AW July 16, 1956, p. 33). In Faceplate, the general layout of the MiG-19 is retained but a new center section with a straight trailing edge is used. Spike protruding from engine inlet forms inlet shock. Pilot visibility appears to be good, particularly toward the rear.



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How T53, T58 Performed in Flight Tests

By Erwin J. Bulban

New York—First details of actual flight test experience with helicopters fitted with new General Electric T58 and Lycoming T53 turboshaft engines indicate that this new generation of lightweight gas turbines provides significant breakthroughs in performance, reliability, safety and maintenance characteristics.

New 800-shp. to 1,000-shp.-class turboshaft engines are designed to power upcoming generation of helicopters. Discussion of their installation in current model rotary wing aircraft, primarily to gain flight experience, was presented to American Society for Mechanical Engineers at recent annual meeting here.

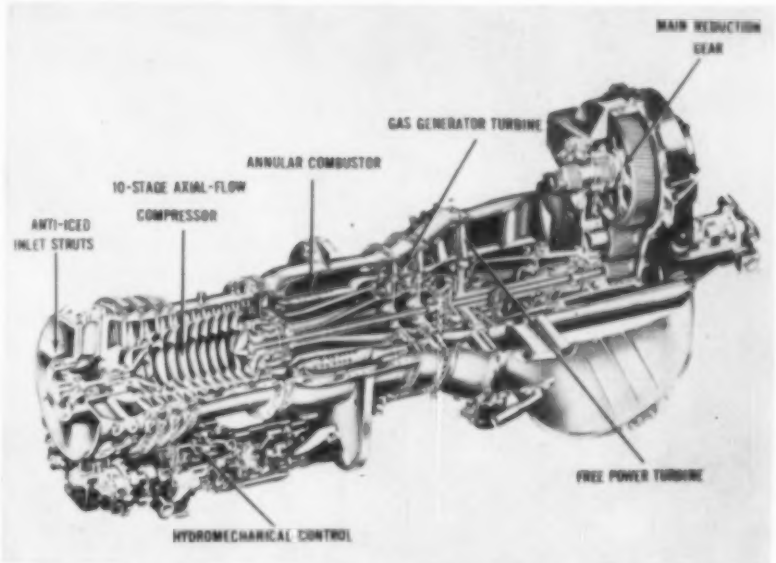
General Electric T58

First group of 22 flight test General Electric T58 engines produced for helicopter development testing had an average performance of 1,060 hp. and specific fuel consumption of 0.65 at military power, exceeding minimum guarantees, N. N. Davis, manager-evaluation, T58 project, Small Aircraft Engine Department, General Electric, told engineers. Some of these powerplants delivered over 1,100 shp. and showed 0.63 sfc. Average engine weight was 324 lb.

Free-turbine design encompasses 10 compressor stages and two turbine stages. The T58 has accumulated some 6,000 hr. of development and operational testing experience, Davis stated. This includes 5,000 hr. of factory development trials, 700 hr. of helicopter rotor operation and 300 hr. of other testing including anti-icing, hot-cold, alternate fuels and production test.

Twin-engine installations are currently undergoing flight testing in a Sikorsky HSS-1 and Vertol H-21D. Engines fitted were a configuration that successfully passed 50-hr. tests in August, 1956. First shipment of experimental test engines was returned to General Electric for overhaul after accumulating 135 hr. of test, indicating that higher life was reached than had been anticipated.

Data obtained from test stand operation using a Sikorsky S-58 rotor system connected to the paired T58s correlates closely with actual flight test data with the complete vehicle, Davis noted. Discussing a test stand operation, he reported that engines automatically changed power output rapidly and positively to maintain a rotor condition previously set by the pilot. During application of a twin-engine "load-burst" on the rotor-equipped test stand, where collective pitch was increased in a tenth of a second to simulate climb, both engine gas generators were operating automatically at a new power level to correspond with the new higher rotor load in about three seconds. Free power turbine speed dropped slightly due to a "speed droop" in the engine fuel control that is designed to prevent erratic engine surging when the pilot varies rotor pitch.



FIRST cutaway of General Electric T58 shows details of the 325 lb., 59 in. long, 16 in. diameter gas turbine. Twin installation is being flight tested in Sikorsky HSS-1 and Vertol H-21D. Kaman HU2K-1 will have single T58. Engine produces about 1,060 hp.

Engine 'Failure'

During the flight test program, engine failure was simulated by chopping the No. 2 engine power control level to the "idle" position in a half-second. Engine torque on this T58 dropped from 670 ft.-lb. to zero in approximately 1½ sec., Davis noted.

Approximately 0.1 sec. after the pilot initiated the engine failure, both fuel flow and torque started to increase on the remaining engine; in another 0.2 sec. the revolutions began to increase; three seconds later the No. 1 engine had picked up the total rotor load and was operating at a new stabilized power setting approximately equal to the total of both engines prior to the simulated failure.

General Electric has tested the T58's compressor in altitude chambers at simulated heights exceeding 35,000 ft. Flight tests have covered operations at 5,000 ft. at airspeeds exceeding 160 mph. with the testsbeds doing chandelles, autorotation, single and twin-engine landings and rates of climb of 2,000 fpm.

Some early problems in testing included fatigue failures in some of the rear compressor stages, following some 2,500 hr. of engine time with 12 compressor assemblies, of which some attained over 300 hr. operating time. Research stages in some compressors developed a fatigue condition in the blade dovetail, Davis reported. In three occasions of blade cracking, only one of these resulted in complete separation, bending blade tips in that stage and causing local damage to the adjacent stators.

Data disclosed that the T58 operated for eight hours on military specification schedule after the failure, without personnel noticing any mechanical malfunction or power changes. Change in compressor efficiency was picked up only by the analytical group processing data. The stage of blades was removed and a new set installed without taking the engine off the test stand and the test was resumed in 24 hr.

Investigation of the incident disclosed that fatigue was caused by excitation in the first torsional mode at compressor speeds corresponding to nor-

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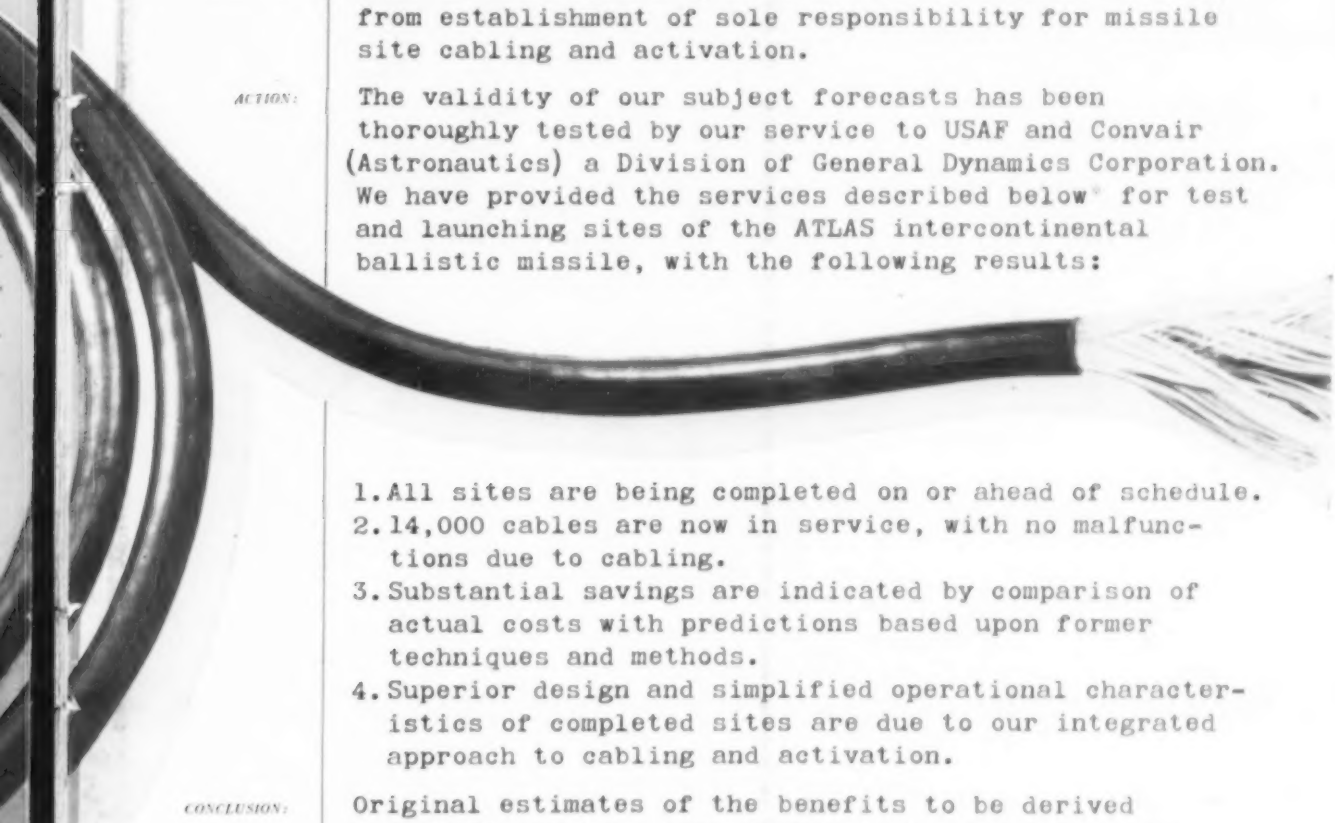

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mal rated power condition. Problem was traced to manufacturing conditions where the shop inadvertently changed the mass and vibration characteristics of late blades in the course of obtaining design limits for thickness and contour. Rotor dovetails were strengthened and vibration characteristics altered to eliminate the problem, Davis stated.

During field operation, an important maintenance consideration has been noticed, according to Davis: Company has found that up to three complete compressor blade stages can be replaced with no detrimental effect on performance or vibration. Also, first stage blades and those in the rear section have been replaced without taking the engine from its mount. Such ability indicates that field maintenance operation will be simplified due to it being unnecessary to pull engines for this reason and subject rotors to time-consuming rebalancing and highspeed testing after blade replacement.

Lycoming T53

Flight test program of the Lycoming YT53-L-1 turboshaft engine in modified Kaman HOK-1 and Bell XH-40 helicopters has provided following preliminary data, given by L. L. Middaugh, chief test pilot, Avco Manufacturing Corp., Lycoming Division:

• **Flights to 15,000 ft.** have disclosed no engine problems, and an excess of power capacity was found available even though the helicopter was at overload gross weight on takeoff—most HOK-1 testbed flying has been with crew of three, plus 750 lb. of instrumentation.

• **T53 has been successfully** tested in altitude chamber at Wright Air Development Center up to 35,000 ft. simulated altitudes, with starts demonstrated down to −65F. According to WADC personnel, it was not possible to "flameout the engine at any altitude below 35,000 ft.," Middaugh told the American Society of Mechanical Engineers.

• **Noise levels** of the T53-powered HOK-1 were found to be lower than its standard piston-engine counterpart, he noted. External noise was found to be about 10 db. less at 200 ft. distance in the former than the piston-powered version, with frequency being about 98 db. at the pilot's ear, about 20 lower than in the piston-engine HOK.

Ability of the turbine engine to give helicopters considerable increase in altitude performance presents a challenge to instrumentation designers to provide future helicopter operators with proper flight attitude references when flying beyond good visual ground reference. For one thing, pilot is seated so far forward that there is little structure ahead of him to indicate flight attitude and, also, the helicopter is capable of

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These factors and a lively imagination combine in the Cherry Research and Development Department to give you the fasteners needed now and tomorrow for efficient aircraft production.

These are reasons why the aircraft industry depends upon the Cherry Division to supply fasteners which make possible better design, speed production, and reduce unit costs.

For information on Cherry fasteners and the tools for installing them, write Townsend Company, Cherry Rivet Division, P. O. Box 2157-N, Santa Ana, California.

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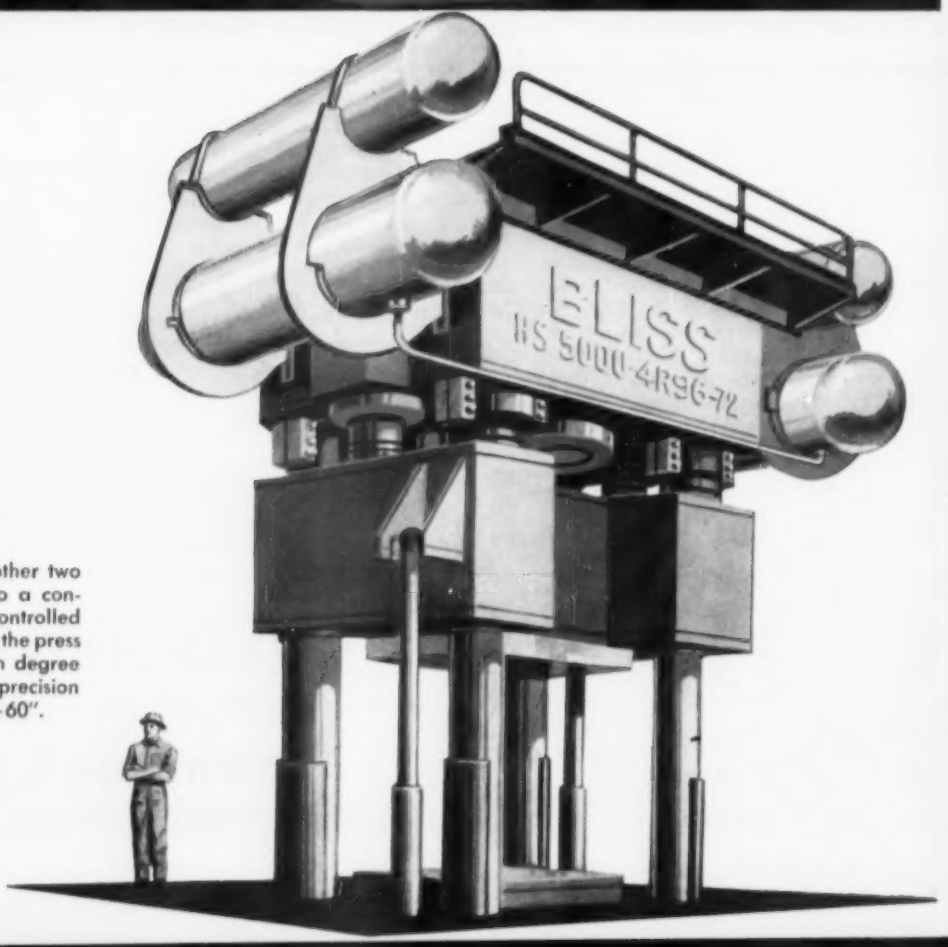
8,000 TON PRESS

. . . Especially designed for Kaiser Aluminum, this press is equipped with side cylinders for pre-forming stock. It can also be used on split die work for forgings requiring undercuts. Press design provides for eccentric or off center loading to compensate for asymmetric forgings. This press has a wide range of controlled pressing speeds and is equipped with stripper and ejector mechanisms to aid in the production of draftless and precision forgings. Bolster size—96" x 72", Stroke—60".



5,000 TON PRESS

. . . Operates automatically, like the other two presses, through a rapid advance into a controlled pressing speed and after a controlled stroke automatically returns. Thus, while the press operates at high speed, it has the high degree of control and accuracy necessary for precision work. Bolster size—84" x 60", Stroke—60".

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They are designed to complement the new 750 and 1500 ton hydraulic presses now operating, plus a wide range of mechanical presses and drop hammers. These modern hydraulic presses will provide larger, more complex forgings to meet your military or commercial requirements.

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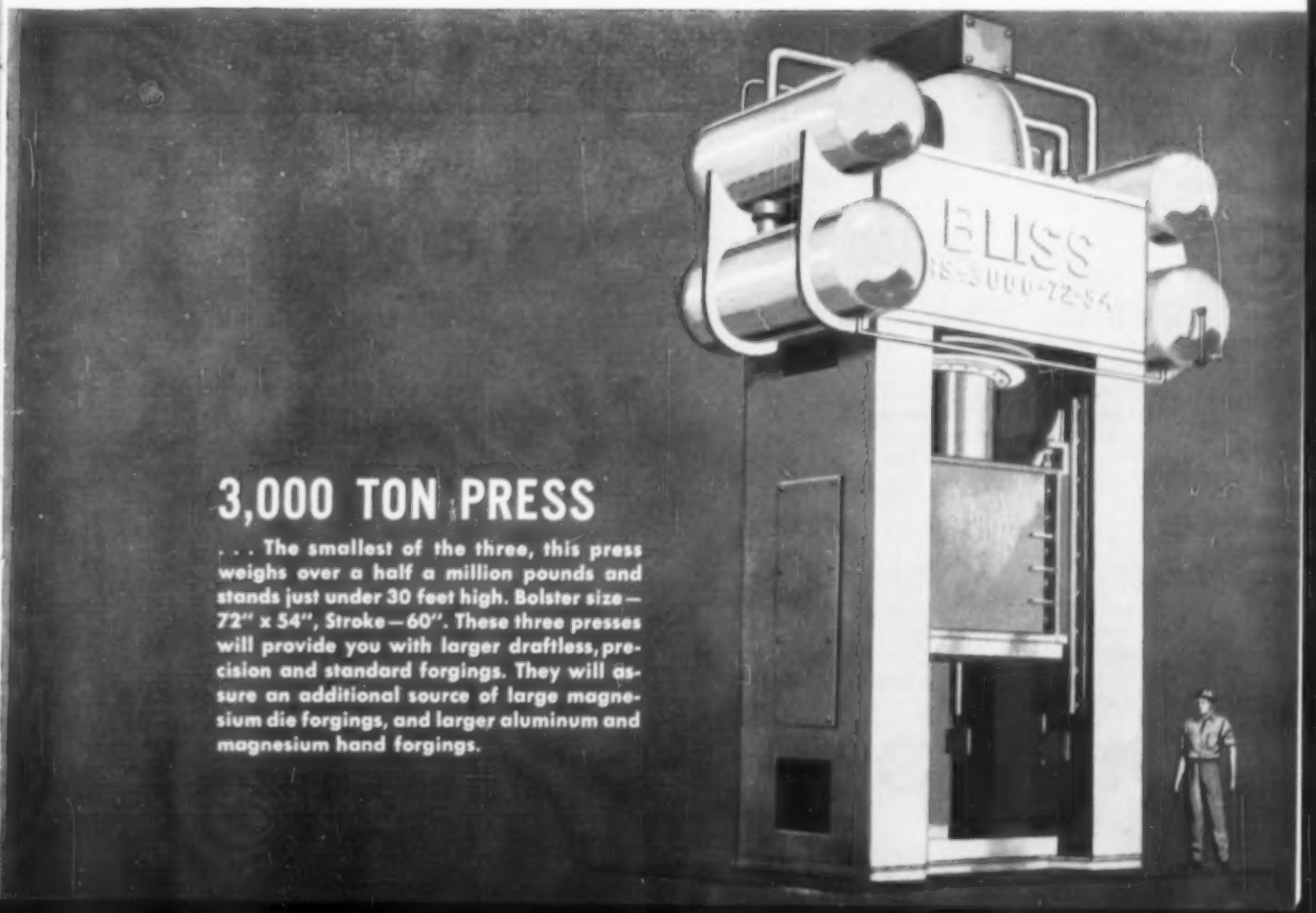
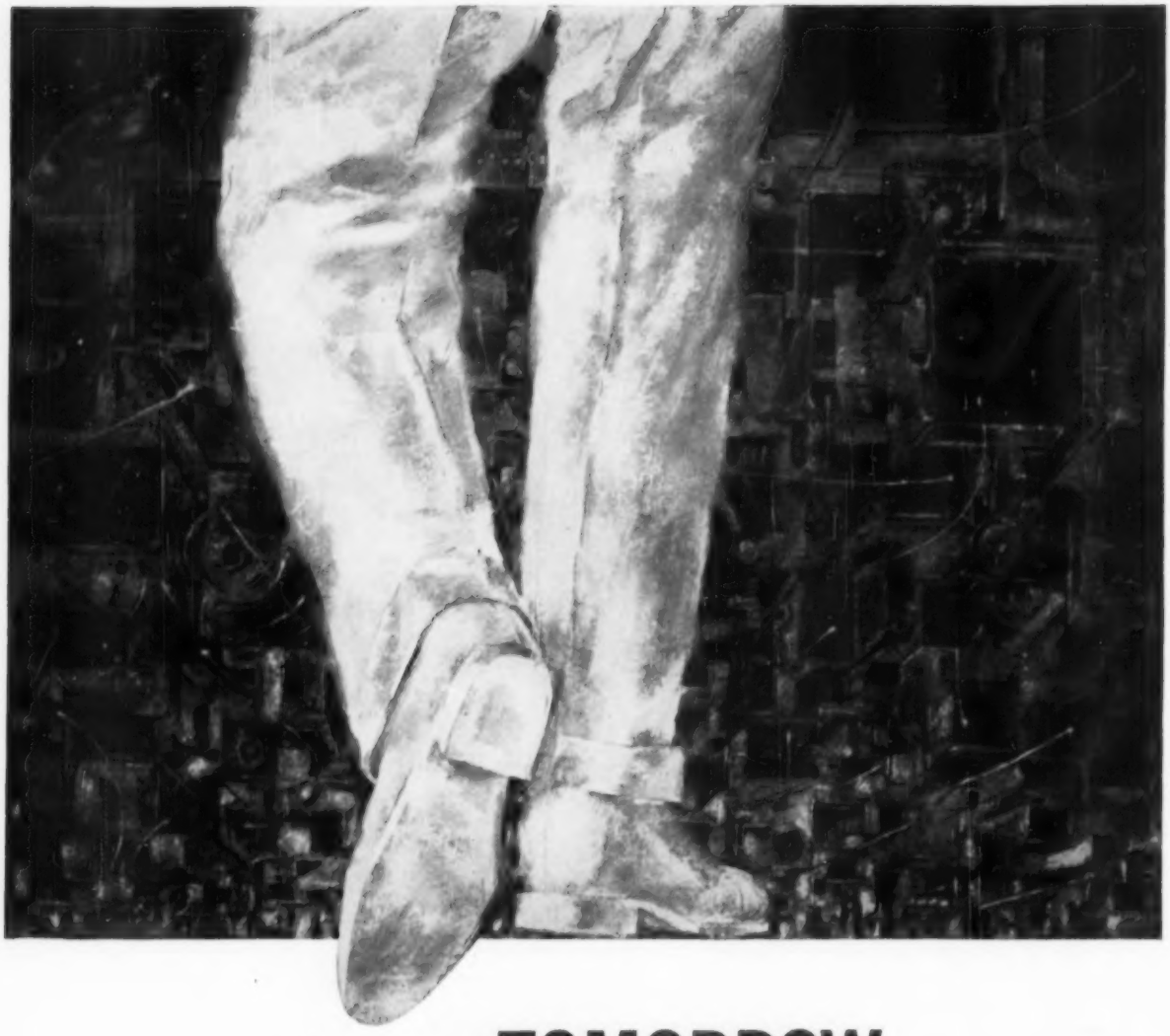


3,000 TON PRESS

. . . The smallest of the three, this press weighs over a half a million pounds and stands just under 30 feet high. Bolster size—72" x 54", Stroke—60". These three presses will provide you with larger draftless, precision and standard forgings. They will assure an additional source of large magnesium die forgings, and larger aluminum and magnesium hand forgings.



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operating beyond the limit of present flight attitude instrumentation, according to Middaugh, particularly at speeds below 50 kt.

Lycoming has provided a makeshift reference in the HOK-1 by placing a yaw boom in front of the cockpit with a weathervane at the front of the boom to give quick indication of relative flight motion.

Engine Control

Engine control in the T53 essentially consists of two speed governors: one controls gas producer speed, the other the power turbine or helicopter rotor speed. Both governors are resettable in flight so that the pilot can select governing rotor revolutions and the highest power at which he wants to operate. Only one of these governors has control over the engine at any given time, this being provided by giving control to the governor which requires the least amount of fuel.

Tests with the HOK-1 testbed have shown that the T53 installation responds rapidly to power demands by the pilot. Acceleration times from flight idle to full power have been 5.5 sec. with approximately 13,500 rpm. on the flight idle gas producer revolutions setting. Another helicopter, Middaugh noted, is operating with gas producer flight idle setting of around 17,000 rpm. so that acceleration takes approximately 2.5 to 3 sec.—indicating that it is not an engine characteristic alone which determines response time, but rather one of engine-rotor combination.

The dual T53 installation in the Vertol 105 (H-21) has shown that concern about power matching a free-turbine multi-engine helicopter package has been unjustified; a 10-hr. tie-down test on the 105 was completed with less than 12 hr. operating time and first flight was made ahead of schedule, Middaugh pointed out.

Following the first flight, approximately 15 flights were made in the first seven days after this event, and no power matching problems have been encountered to date, he added.

Navy Outlines Needs In Helicopter Designs

Navy studies of future helicopter missions indicate that a power spectrum of from 40 shp. through 3,500 shp. will be required, Lt. Cmdr. Robert Thoe, Power Plant Division, BuAer, told the American Society of Mechanical Engineers at a joint session of the Aviation and Gas Turbine Power Divisions.

Lt. Cmdr. Thoe reviewed helicopter requirements in relation to engine needs as follows:

• **One-man rotorcycle-platform** requir-

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GOOD THERMAL CHARACTERISTICS... The thermal expansion characteristics of new "NO-MAG" cable are much closer than those of standard stainless steel or carbon steel cables to the characteristics of aluminum alloys used in aircraft. This greatly simplifies maintaining cable tension under various changes in temperature.

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HIGH ABRASION RESISTANCE . . . New "NO-MAG" cable shows greater abrasion resistance than standard stainless steel aircraft cables.

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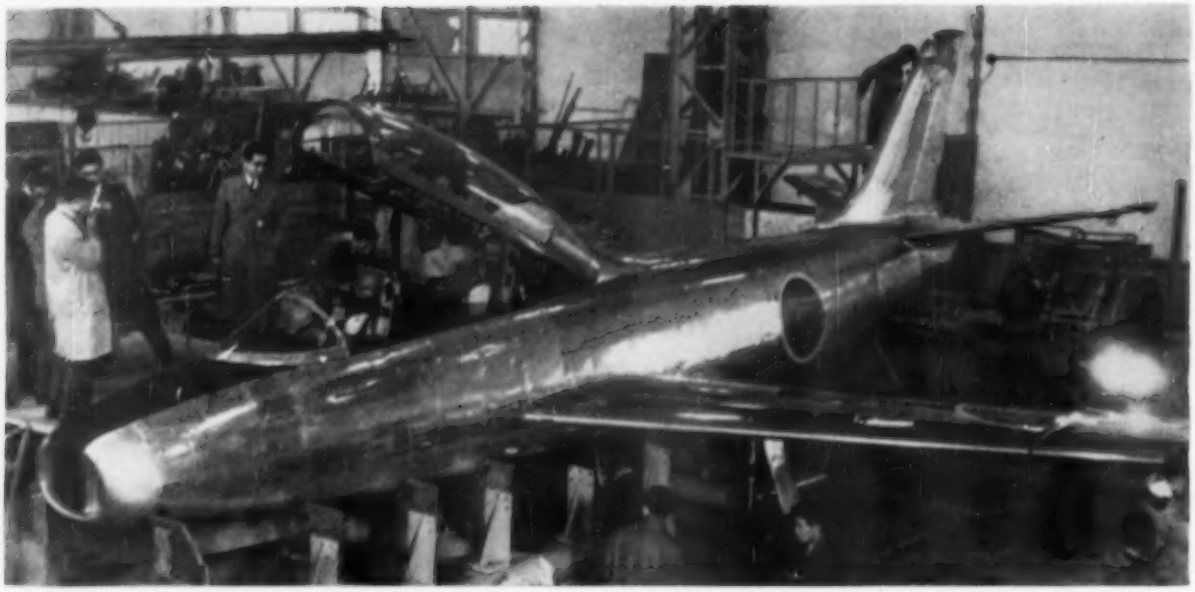

Medium Trainer Is Japan's First Domestically Built Jet

First photo shows the first of three T1F2s ordered by the Japan Defense Agency for Air Self-Defense Force being built at the Utsunomiya plant of Fuji Heavy Industries Co. Medium jet trainer is 40 ft. long, 12.5 ft. high, has 34.4 ft. wingspan. Two-seater is designed to attain altitude of 40,000 ft., cruise for about 2 hr. at 20,000 ft. Top speed will be about Mach 0.85. All parts will be Japanese except Bristol engine.

ing lightweight moderate fuel consumption engines in 50 shp. class.

• **Trainer helicopter** using 400-shp.-class engine.

• **Utility and observation type** requiring 1,000 shp. powerplant.

• **Anti-submarine** warfare helicopter, which will need 2,000-shp.-3,000-shp. engines, having ability to operate a large amount of time at high percentages of normal rated power.

• **Minesweeping helicopter** using 2,500-shp.-class turbine, capable of operating in unusual attitudes such as tilt or list to one side, complicating lubrication problems.

• **Assault transport** needing about 2,500 shp. engine or multiple installations.

• **Flying crane** having great lifting capacity at expense of fuel consumption and range; a rotor-tip drive for this requirement seems to be more efficient than a geared gas turbine, Cmdr. Thoe noted.

Current helicopter turboshaft engine projects falling in this spectrum include the 55-shp. Solar T62 and T66, 400-shp. Boeing T60, 800-shp. Lycoming T53, 1,000-shp. General Electric T58, 1,600-shp. Lycoming T55 and 2,500-shp. General Electric T64. These engines, in single or multiple installations, appear to provide power requirements of Navy on its future projects, Cmdr. Thoe indicated.

Current Navy helicopter operations problems requiring solution include: Means of protecting turbine powerplants from vast quantities of dust, sand and other foreign objects inhaled while operating from unprepared airfields; protective coating for magnesium engine parts exposed to salt air and spray (present coatings are ineffective and as a result Navy requirements call for elimination of magnesium parts in these areas in its engines); ability of fuel control components to meet new military specification of 500-hr. test using fuel contaminated with new mixture comprising iron-oxide particles, salt water, dust and cellulose fibers.

Rolls-Royce Turbojet Completes Type Test

London—Rolls-Royce reports that its Conway R. Co. 11 bypass jet engine has completed its official type test with a dry rating of 17,250 lb. thrust.

The test was run to combined U.S. and U.K. specifications.

The company says a large part of the test actually was run at a substantially higher thrust. Specific fuel consumption is believed to have been lower than that of any type-tested military jet engine in the world.

Civil rating of the Conway is 16,500 lb. The first civil Conways are to be delivered to Boeing and Douglas next summer. In addition to powering the American jets, Conways also are specified for the 35 Vickers VC-10s on order for British Overseas Airways Corp.

The Mk. 2 Handley Page Victor bomber is to be equipped with the military version of the Conway.

Meanwhile, the Ministry of Supply announced officially the existence of the DGJ. 10 version of the de Havilland Gyron Junior. No further details were given.

Cast Aluminum Alloy Cuts Costs, Weight

A new aluminum alloy, designated Tens-50, developed by North American Aviation's Los Angeles Division, is now being cast in quantity by Rayson Casting and Mfg. Co., Gardena, Calif.

Parts cast in new alloy are 25 to 50% stronger and lighter than those made from conventional materials and cost less, North American says. One part which cost $350 to produce by machin-

D-RING above, behind pilot's head is cast from Tens-50 to cut weight, add strength

ing of bar stock costs about $15 cast in Tens-50, is equal in strength and lighter in weight.

Rayson is now casting the new alloy as a pylon used to suspend fuel tanks and bombs from the F-100 Super Sabre. It has had a lower rejection rate through X-ray examination of castings than was found when the pylons were cast in conventional materials.

Curtiss-Wright Cuts Turbomotors Staff

Turbomotors Division, Curtiss-Wright Corp., has been partially disbanded in a retrenchment move. The division, which was scheduled to move into its newly constructed quarters in Trenton, N. J., has been integrated with the Wright-Aeronautical Division of the parent company, Curtiss-Wright.

However, it is likely that for the present Turbomotors will continue to remain a division on the Curtiss-Wright organizational chart under general manager E. W. Conlon, a Curtiss-Wright spokesman told AVIATION WEEK.

The small (less than 100 men according to a Curtiss-Wright source) division was composed of turbojet design engineers, some formerly with Fairchild Engine Division, Fairchild Engine and Airplane Co., Deer Park, N. Y., who were making mainly paper studies under USAF contract on small, lightweight gas turbine engines (AW May 20, p. 57).

Turbomotors' new quarters will now be occupied by Curtiss-Wright Industrial and Scientific Products Division, which makes ultrasonic testing and cleaning equipment.

Reason given by one former Turbomotor engineer for downgrading of the division was failure of paper engine studies to materialize into engine development and production programs profitable to cost-conscious Curtiss-Wright.

Australia Plans Chain Of Strategic Airfields

Melbourne—New construction program to cost approximately $7 million will mark the latest stage in the development of a chain of strategic airfields in Australia.

The $7 million will be spent on reconstruction or resurfacing of six airfields for RAAF's jet aircraft. The airfields at Alice Springs and at Learmonth will be reconstructed and those at Williamstown, N.S.W.; East Sale, Victoria; Pearce, Western Australia and Amberley, Queensland, would be overlaid with two inches of bituminous concrete.

The Williamstown and Alice Springs projects will also benefit civil aircraft which use these airports.

Construction is still proceeding on the 13,000 ft. strip at Darwin and at Townsville. Extensive work has been completed at Manus Island.

German Engineers Designing India's Jet

Bonn—A team of German aircraft engineers headed by Dr. Kurt Tank reports good progress on the supersonic jet fighter they are developing for the governmental Hindustan Aircraft Ltd. in Bangalore, south India (AW Dec. 2, p. 33).

The next step reportedly will be the construction of some experimental models. Only after these have been test flown will the final model be designed.

It may take three years before the fighter can be put into operation.

Dr. Tank, pre-war chief engineer of Focke-Wulfe, left Germany shortly after World War II for Argentina. After Peron's fall, he went to India with his staff.

MULTI-TUBE silencers have been flight tested on cross country flights by Boeing on the prototype 707 jetliner. Company said noise was comparable to that of a present-day airliner.

Boeing Flight Tests 707 Silencers

A completely new tailpipe design which includes a 21-tube sound suppressor compatible with a thrust reverser has made several cross country flights on Boeing's prototype 707 jetliner.

Flights, which were made in late September, were round trips from Seattle to Los Angeles and Seattle to Wichita, Kan.

Suppressors are also installed on number one production 707 scheduled to fly later this month.

Boeing would not disclose the amount of the thrust and weight penalty imposed by the device.

Flights of the 707 prototype with the new suppressor followed intensive tests of nine different full-scale silencers installed on the plane at various times for a period of more than one year. Configurations of the nine full-scale suppressors were chosen on the basis of laboratory tests of more than 500 scale model silencers.

Tests with the 21-tube suppressor show that the device not only muffled jet exhaust noise but changed the character of the sound so that it is "no more noticeable to persons in the vicinity of airports than the sound produced by present-day airliners," says Boeing.

In service, the sound suppressors will be combined with thrust reversers and fitted as a unit to each engine.

Boeing's sound suppressor development began with the pioneering work of British scientists, notably Prof. M. J. Lighthill of the University of Manchester, F. B. Greatorex of Rolls-Royce Ltd., and Prof. E. J. Richards of the University of Southampton.

Cost of developing the combination sound suppressor/thrust reverser has been several million dollars, including research, according to Boeing.

F-107A Design

North American F-107A fighter-bomber, performing loop (top), has all-movable vertical and horizontal stabilizers, an outgrowth of the all-movable horizontal stabilizers that were incorporated in North American's F-86 and F-100. Spoiler system for lateral control consists of hinged doors on upper and lower wing skins that control passage of air over and under wings during high-speed maneuvers. Maximum air speed is more than 1,300 mph.; the F-107A flies at about Mach 2 in level and climbing flight; exceeds Mach 1 in a vertical climb. Overhead duct was designed to provide maximum efficiency for the Pratt & Whitney J75 turbine engine, which is in the 20,000 lb. thrust class. The F-107A has been delivered to the high-speed flight station of the National Advisory Committee for Aeronautics at Edwards AFB, Calif., for evaluation (AW Nov. 25, p. 27). Approximate dimensions are length, 62 ft., height, 19 ft., wingspan, 37 ft.

Details Include Belly Fuel Pod, Overhead Air Intake

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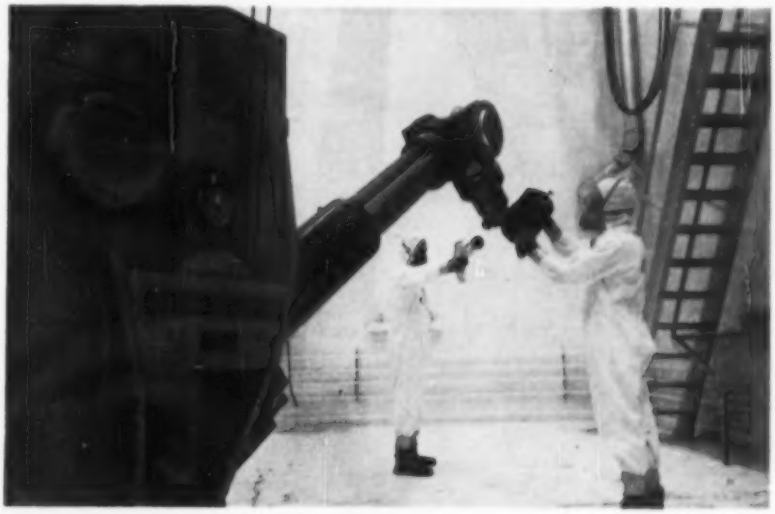
OFFICES IN PRINCIPAL CITIES THROUGHOUT THE WORLD

Manipulators Serve Nuclear Aircraft Units

Manipulators—agile, electrically-controlled mechanical hands which can perform jobs with almost the dexterity of human hands—are being used to maintain radioactive components of nuclear aircraft propulsion equipment at a large "hot" shop used by General Electric Co. at Idaho Falls, Idaho (AW June 24, p. 107). Nuclear-powered aircraft project is labeled WS 125A.

Because of the relatively great distances between manipulator operators and components being handled, technicians must possess unusually good stereoscopic vision, which forced General Electric to establish a special stereoscopic vision screening program to select only those men with sufficiently good depth perception to perform the exacting tasks required in the hot shop.

REMOTELY controlled manipulator moves radioactive equipment (above) at AEC nuclear propulsion test site at Idaho Falls, Idaho. Below, manipulator hands unit to technician



Part of AEC

The facility, which is 160 ft. long, 50 ft. wide and 63 ft. high, is part of the Atomic Energy Commission's test operations.

General Electric says that the mechanical hands used in the shop have the capability of disassembling a jet aircraft engine "bolt-by-bolt." Company appears to be working on one of its own J47 engines, judging from the interior photo of the shop.

Six manipulators are used in the shop. One, dubbed "O'Man," is an outsize mechanical arm suspended from a bridge crane so that it can cover the entire working area of the shop. The manipulator can handle from 500 to 3,000 lb. of work, depending on the arm's length and position. O'Man was designed and built by General Electric. Also included in the shop are a much smaller master-slave manipulator for making intricate mechanical adjustments and four electrically-controlled wall-mounted mechanical hands.

Manipulator operators are protected from radioactive equipment by concrete walls seven feet thick. The nine windows in the walls are six feet thick and are made of lead glass. Each window contains 500 gal. of zinc bromide to protect operators from any stray nuclear radiation.

Radio Contact

Radio contact can be maintained by operators in the control galleries with other operating sites and with a lead-shielded locomotive used to haul equipment in and out of the facility.

Enough controls are located at each window to operate any piece of servicing equipment in the entire work area.

Two large capacity turntables on the floor of the shop are used to rotate the heavy equipment maintained in the facility, to provide easier access by the manipulators and to give a better view from any of the nine observation windows.

A pool 120 ft. long, 60 ft. across and 24 ft. deep, filled with very pure distilled water, is used to store fuel elements and other radioactive units. Pool is connected to the hot shop by a canal.

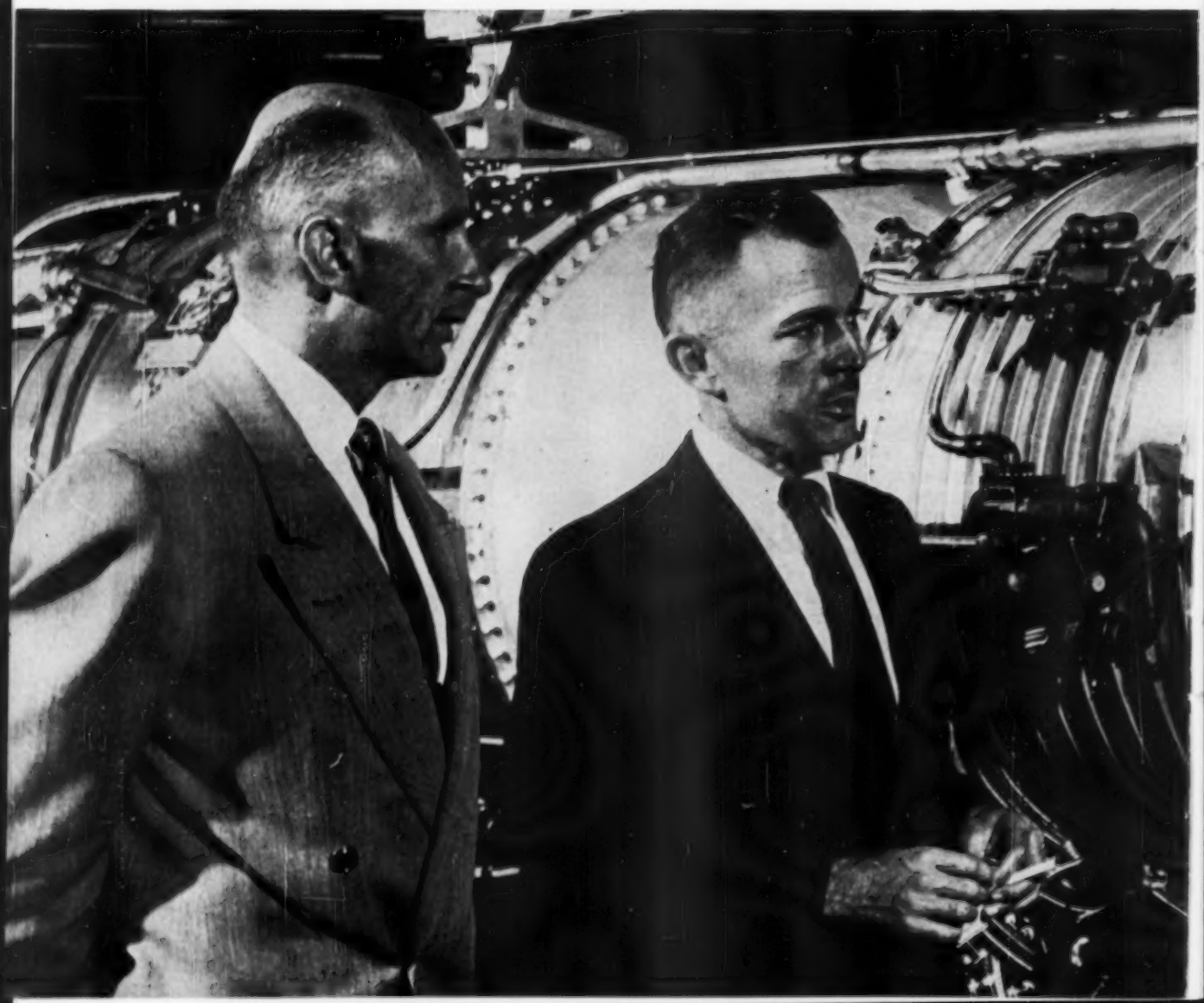
Also connected with the shop are several smaller shops for handling radioactive equipment.

One of these has facilities for servicing O'Man and other remote handling equipment.

Shop is serviced by a railroad track system which enters the facility through large remote-controlled double doors at

A SPECIAL REPORT FROM GENERAL ELECTRIC ON

Variable-Stator Compressors: Key to More Jet Power Per Pound of Engine



In flight and test, General Electric's powerful J79 turbojet has proved to the entire aviation industry what G-E powerplant experts had predicted: the variable-stator compressor holds the key to greater jet power at less engine weight.

Compared to other methods of achieving high pressure ratio in a jet engine, the variable-stator method is simple. Variable-geometry keeps engine weight down without sacrificing durability, provides positive compressor control. And because the variable-stator makes possible single-rotor design, engines that use it are easier to overhaul and maintain.

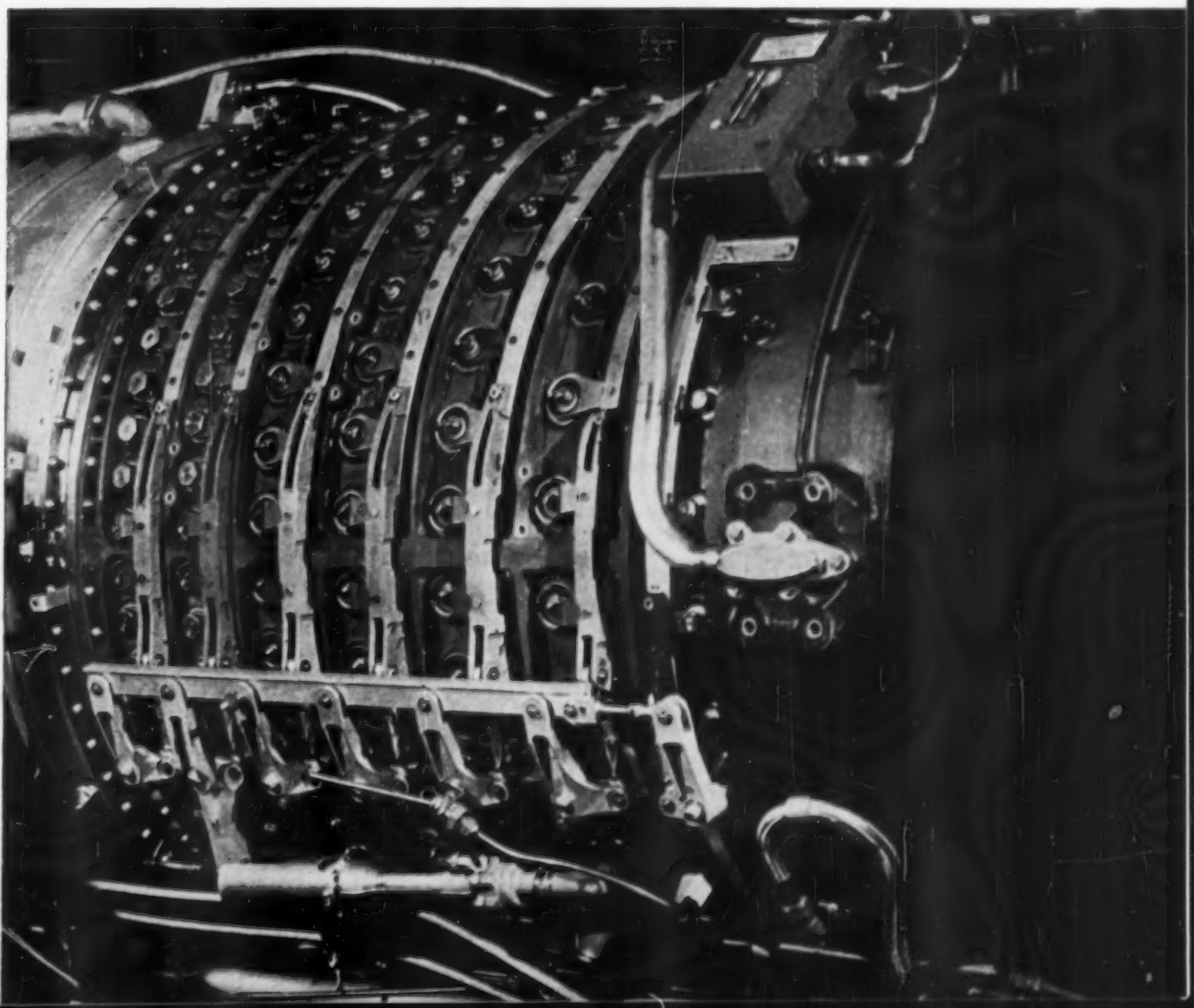
Thousands of J79 flight hours in USAF's Convair B-58 and Lockheed F-104A have demonstrated the fundamental soundness and dependability of the variable-stator compressor. Today, the sound of still newer variable-stator engines inside G-E test cells heralds the approach of a whole new era of high performance jet flight. ***General Electric Company, Cincinnati 15, Ohio.*** 235-26

ABOVE: G.E.'s commercial turbojet, the CJ-805. Engine capitalizes on variable-stator compressor to help reduce weight, and so increase airline profit potential.

Progress Is Our Most Important Product

GENERAL ELECTRIC

BELOW: General Electric's Gerhard Neumann and Neil Burgess examine J79 variable-stator compressor. J79 is first U.S. turbojet to combine supersonic power ***and*** light weight.



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CONTINUOUS TESTING and rigid quality controls are standard procedure at Houdaille. Production dampers must undergo exhaustive tests for several days on equipment such as this, to make certain each unit meets all phases of the customer's specifications.

WRITE FOR TECHNICAL BULLETIN giving complete performance and operational data. For engineering assistance on flutter damping applications at the aircraft design stage, contact Buffalo Hydraulics Division, Dept. AW.

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Pioneers in developing aircraft vibration-control devices

CONTROL room is protected from work area by 7 ft. thick walls and 6 ft. thick lead glass windows (left). Railroad transports equipment into radioactive maintenance shop (right).

one end. Smaller personnel entrances are also provided.

Unusual problem in operating the hot shop is to obtain personnel with sufficient depth perception to handle the manipulators precisely while far removed from the objects to be handled.

Two of the 6-ft.-thick windows are 30 ft. above the shop floor and six are 18 ft. above it. (Ninth window is in the handling equipment maintenance cell.)

Complicating the problem of achieving sufficient depth perception to operate the manipulators accurately is the fact that the size and color of the objects being handled are not always apparent to the operator, while frequently an absence of shadows hinders depth perception.

To alleviate this problem, General Electric provides such viewing aids as binoculars, spotting telescopes, mirrors and closed circuit industrial television systems.

Company is preparing to install a television network in the shop which will include black-and-white, color and three dimension stereo vision, and any combination of these with viewing screens at all operator locations.

General Electric says that, since the average person has only about 70% stereoscopic vision, and less than one person in 10 has perfect stereo as well as perfect vision, the company has to select personnel who can develop 100% stereoscopic vision with a reasonable amount of exercise and training.

To select manipulator technicians with sufficient stereoscopic vision to operate the devices with adequate proficiency, General Electric established this four-step personnel selection program:

- **Examination** of prospective manipulator operators by local oculists.
- **Elimination** of candidates with less than 80% stereoscopic vision.
- **Evaluation** of candidates passing this test to determine whether they can benefit from training and exercise several hours a day to improve their stereoscopic vision.
- **Institution** of visual training and exercise, including on-the-job training.

Engine Cleaning Facility Halves Costs

Oakland, Calif.—Automatic cleaning facility at Oakland Aircraft Engine Service's new engine overhaul plant adjacent to Oakland International Airport has reduced engine cleaning costs by 50%, according to President William R. Rivers.

Machine is just a small part of company's modern and highly mechanized plant, completed last February. Plant size is 126,000 sq. ft., twice as big as old facility at the airport. To date, business volume has increased one-third since the move.

Company's biggest current customer is the Air Force. The firm has Civil Aeronautics Administration approval for all aircraft engine overhaul operations in powerplant classes I and II. It handles engines in sizes O-290-C4 to R-2800, although most are R-985 and higher horsepower. Using production line methods, the company overhauls five R-2800 engines and one R-2000 engine plus more than 1,500 components and spare parts daily.

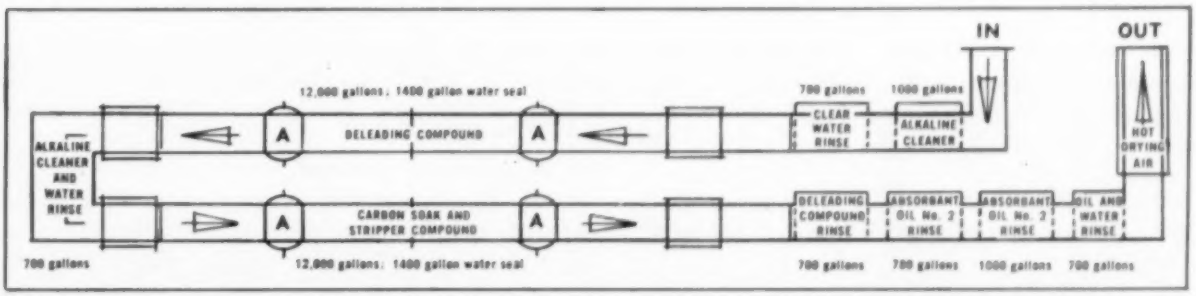
Company is continuing operation of shops at Oakland Airport, where carburetor, magneto and plating work is done, and where test stands are located.

Oakland Aircraft Engine service currently has 400 employes, but normally has more than 750 when business is seasonally heavier.

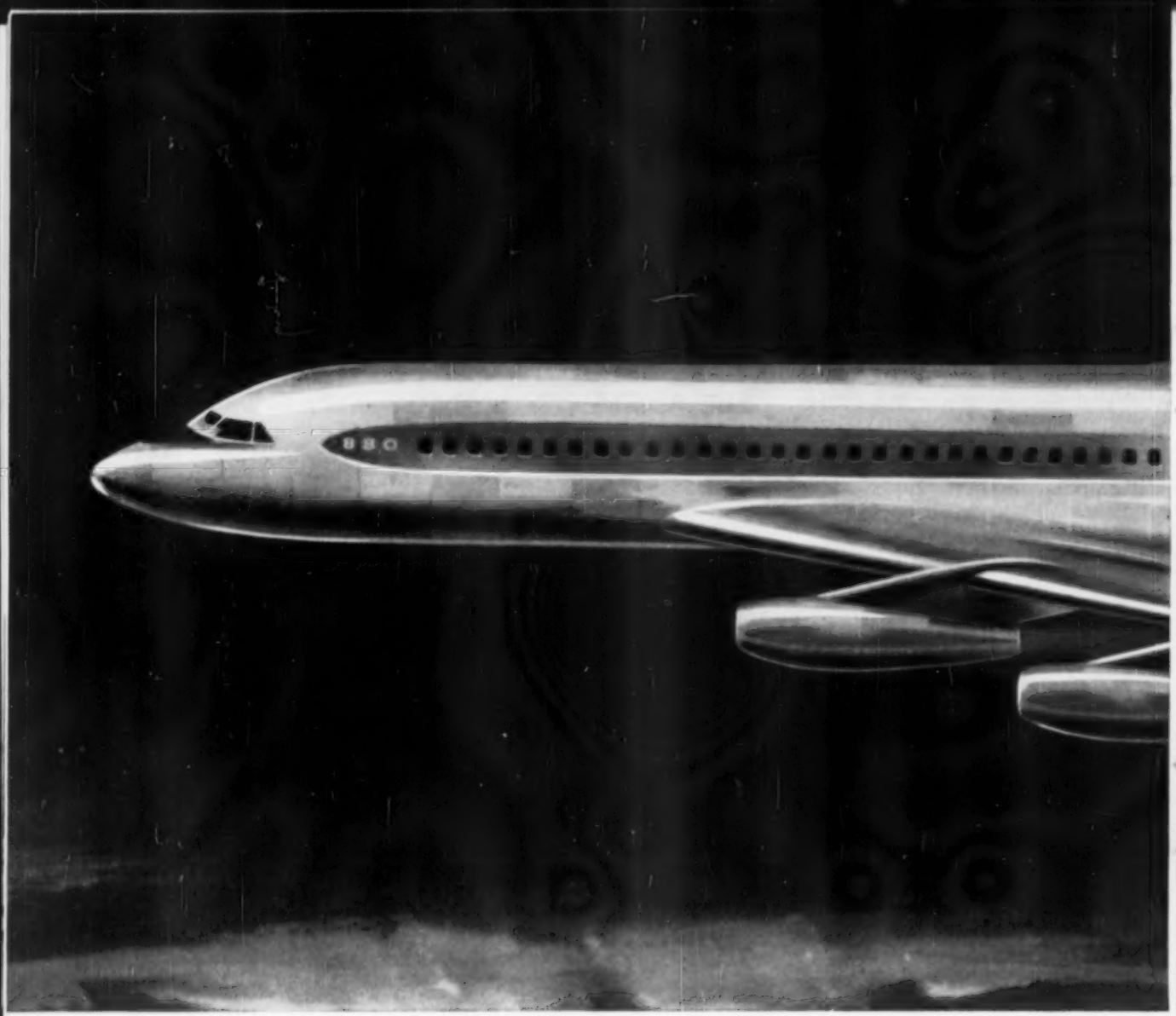
Cleaning system was built to company specifications at a cost of $125,000. An additional $50,000 bought cleaning agents, which must be renewed constantly. Annual costs for chemical renewal are $3,600.

Using the new cleaning facility, the company can accomplish in two 8-hr. shifts what it formerly did in three shifts, when parts were hoisted into tanks of cleaning solution, soaked for 4 hr. and hand-cleaned. Actual capacity of the new cleaning unit is 16 engines in a 16 hr. day.

Cleaning process begins after engines are disassembled and inspected visually. Unserviceable parts get a red tag and



AUTOMATIC cleaning facility at Oakland Aircraft Engine Service operates like production line. Capacity is 16 engines in 16-hr. day.



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Skydrol is the practical solution to concern about danger from hydraulic fluid leaks. It is a fire-resistant, lubricating chemical, not an oil. Today, more than 700 airplanes in 40 of the world's major airlines are protected by Skydrol. They have logged over 8,000,000 flying hours . . . overwhelming proof that Skydrol gives practical operation. Tomorrow, when a TWA Convair 880 speeds from New York to Los Angeles just a step behind the sun, it will enjoy proved service from Skydrol 500.

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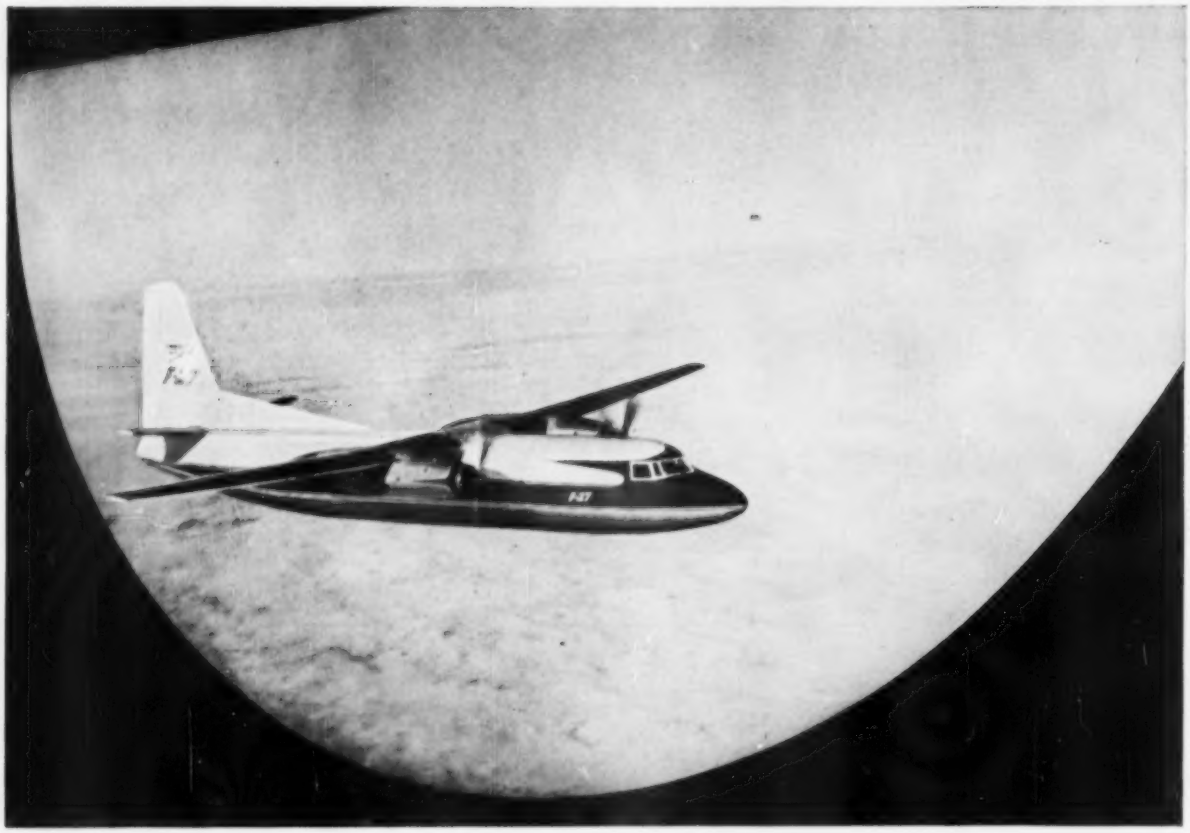

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F-27

World's first twin propjet transport flies with Bridgeport Aluminum

Fairchild's revolutionary new F-27—world's first twin propjet transport—is ready to go into service as a principal short-haul and feeder-line carrier. Its outstanding features are high performance characteristics—propjet speed, reduced vibration and lower sound level, deluxe air-conditioned pressurized cabins and economical operating costs.

Playing vital roles in these modern 300 mph-plus class transports are light, high-strength Bridgeport Aluminum Extrusions. The new Fairchild F-27 is one of the many leading aircraft—both military and commercial—that rely on Bridgeport Aluminum Extrusions for dependable performance. The close tolerances . . . excellent finish . . . fast, on-time deliveries and other plus advantages make Bridgeport a dependable source for supply when high-strength aluminum extrusions and forgings are required. For prompt, dependable service, call your Bridgeport sales office.

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SMALL parts at Oakland Aircraft Engine Service go from plant to cleaning facility on conveyor, are placed in baskets which are hung on overhead conveyor for trip through facility.

are set aside. Those found usable or reworkable are carried to the cleaning facility by an endless neoprene conveyor more than 100 ft. long.

Large parts such as cylinders are hung from the conveyor line, while smaller parts are put in wire baskets which also are hooked to the line, either singly or in pairs.

Automatic cleaning facility, located outside the plant walls, is 288 ft. long, U-shaped and made of concrete and steel. Parts go through a 3 hr. 20 min. cleaning process.

Parts are first plunged into an alkaline spray bath, where 1,000 gal. of soap and water at 140-180F are used in the de-greasing and cleaning process. This alkaline treatment, plus a 700-gal. clear-water rinse, comprise the first two stages of the 10-stage cleaning line. Other stages are:

- **Parts are submerged** in tank containing 12,000 gal. of de-leading compound (Delco Material 946) with 1,400 gal. water seal. Lead and paint are removed. Temperature is 140F.
- **Parts get another** 140-180F alkaline bath and water rinse, make U-turn and begin final trip.
- **Carbon is removed** with 12,000 gal. of 90F carbon soak and stripper compound with 1,400 gal. water seal.
- **Parts are rinsed** in 700 gal. of de-leading compound. (Product used is Standard Oil Co. of California's absorption oil No. 2).
- **Rinse is repeated,** using 700 gal. and then 1,000 gal. of solution. (Two stages.)
- **Parts get oil coating** in 700 gal. tank of soluble oil and water at 140-180F to prevent rust.
- **Final step** is hot-air blowing system, which blows water off and dries parts. Temperature is 210F. Parts return to plant and are removed from hooks manually, readied for return down production line for further inspection and overhaul. Only stages three and five are dip tanks. In other stages, parts are sprayed.

Cleaner is equipped with four fan-operated agitators. Fans can be removed for cold-still or hot-still operation, or can be used for cold-agitated or hot-agitated operation.

One man oversees the cleaning system, checking for proper performance of the facility and the 180 hp. boiler which operates it, and keeping the area clean.

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Output Voltage: Any from 25-1200 VDC
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Output Power: 50 V.A. square wave
Regulation: Frequency: ±0.5%
(line & load) Voltage: ±2.0%
Size & Weight: 3" ODx3⅜" high; 19 oz.

PULSED OUTPUT Model 591-P

Input Voltage: 24-30 VDC
Output Voltage: 20-2000 V pulses
Pulse Rate: 500-3000 per sec.
Peak Power: 150 watts at 20% duty cycle
Size & Weight: 3" ODx3¾" high; 19 oz.

Write or 'phone for literature

ARNOLD MAGNETICS CORPORATION
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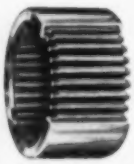
REpublic 1-6344

Each B-52 Stratofortress, newest bomber of the Strategic Air Command, uses nearly 500 Torrington Bearings of the types shown below. Important applications include landing flap devices and carriage assemblies and landing gears.

Cam Followers

NBK



Needle Bearings

Heavy Duty Needle Bearings

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Operation Power Flight, first non-stop jet around-the-world flight, demonstrated the strength of U. S. air power and the stamina of the Boeing B-52 Stratofortress, newest bomber of the Strategic Air Command.

It demonstrated, too, the vital place won in aircraft design and performance by Torrington Needle Bearings. These compact, lightweight units provide the highest possible capacity in minimum cross section. Needle Bearings also permit efficient relubrication and smooth antifriction performance for long service life.

The Torrington Company pioneered the development of Needle Bearings, working with the aviation industry on thousands of installations of special aircraft bearing assemblies. Your Torrington representative will be glad to put this engineering experience at your service. *The Torrington Company*, Torrington, Conn.—and South Bend 21, Ind.

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ACCESS doors to Hamilton Standard air conditioning system are shown on 880 mockup.

Convair 880s to Get Freon Air Regulators

More than $2 million of freon air conditioning equipment has been ordered from Hamilton Standard Division, United Aircraft Corp., by Convair for its 880 jet transports.

System will supply air-conditioned and pressurized air for the plane's cabin and flight deck at a stabilized temperature of 75F in flight or 80F on the ground and will change the air completely every 2½ minutes. Humidity will be held at 40% and cabin pressure to an equivalent of 8,000 ft. when the plane is at 35,000 ft.

System will remove 240,000 Btu. per hr. from the air circulating in the cabin. During normal cruising conditions, system's supercharger will deliver 100 hp., but at its maximum speed at sea level, output can be raised to 600 hp. Unit's stainless steel housing will contain fragments of either turbine or compressor wheel in the event of failure. Turbine's maximum speed is 48,000 rpm.

The 880 will incorporate two identical air conditioning systems. Although cross-ducted, each system can operate individually. Dual system has a capacity of 20 tons of ice per 24 hr. period.

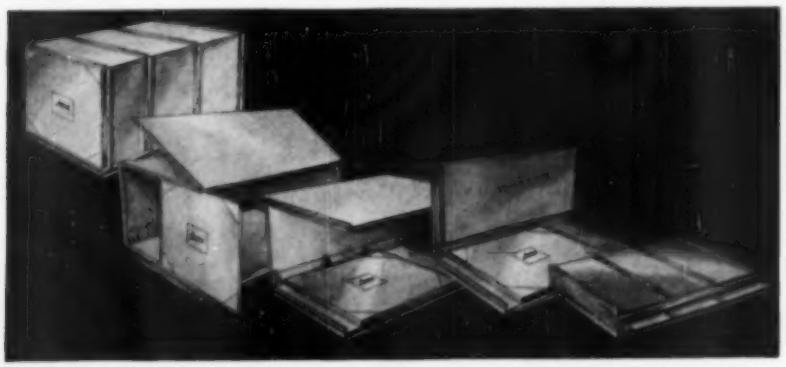
Components for cabin pressure regulation will be supplied by AiResearch Mfg. Co. Hamilton Standard will begin delivering equipment for the first 48 880s in March, 1958.

Collapsible Container Saves Air Cargo Space

New, lightweight, collapsible cargo container for air cargo carriers has just been put into production by Jeta Metal Fabricators, Inc. United Air Lines and American Airlines began running tests on one container each a few weeks ago.

Aluminum container, which stands 5 ft. high, can be collapsed to ¼th that height—13 in.—by two men in less than a minute when it is to be deadheaded back to destination. Other specifications of the container are:

Weight empty, 230 lb.; load capacity, 4,000 lb.; outside length, 84 in.; outside width, 51 in.; outside height, 62 in.; outside cubage, 154 cu./ft.; inside cubage, 126 cu./ft.



COLLAPSIBLE air cargo container stands 5 ft. high, can be reduced quickly to 13 in.

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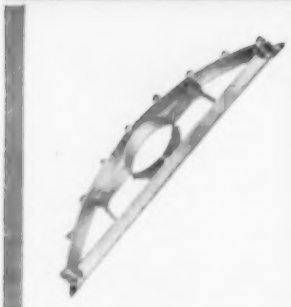

A REPORT ON THE FIRST SUCCESSFUL PROCESS FOR CHEMICALLY MILLING LIGHT METAL CASTINGS

In high speed jets, rockets, and missiles the price tag on every ounce of excess weight is enormous. Even the use of lightweight aluminum and magnesium alloys wherever possible leaves room for improvement. For while part thickness is often determined by structural requirements, it is frequently a function of the metalworking processes used. Castings, for example, must have sufficient wall thickness to assure sound structure throughout. Thinner sections are generally achieved by machining the parts after casting. This is often an expensive and sometimes impossible task, especially where complex contours or double walls are involved.

Enter Chemical Milling

The first break came when a solution was discovered to the same problem as it affected wrought parts. The solution—familiar to every high school chemistry student—was based on the consumption of metals by powerful reagents. Its successful application to metalworking production presaged significant strides in weight reduction. But when the same techniques were applied to castings, results were extremely poor.

Rolle research immediately began laboratory tests to discover the reason for the failure, and found it often lay *in* the castings. Even minor imperfections in the casting surface unbalanced the process of metal removal—enlarging any defects present. Rolle also found, after much searching, that only certain reagents in certain concentrations—depending on both the part cast and the alloy used—could guarantee success. It has taken almost two years of exhaustive research to refine this process to the extent that it can now take its place as an accepted metalworking technique. Parts can now be designed for casting that could only be constructed by sheet fabrication techniques in the past.

Half The Wall Thickness

The major advantages of this chemical milling process are pretty much wrapped up in the single figure 0.060"—the wall thickness which Rolle can consistently meet by the process. The importance of this figure is readily comprehended by comparing with it the conventional limit on casting wall thickness—.125". Rigid control techniques, developed in the laboratory, even permit an overall improvement in dimensional tolerances of the part as a result of the chemical milling process. And at the same time, surface finishes of an order of 100 microinches or better can be consistently achieved.

There are two ways you can take advantage of this Rolle technique for chemical milling. One requires the controlled removal of metal from the entire surface area of the part. Allowance can be made in the pattern for holding heavy sections and critical dimensions despite chemical metal removal. The other method, useful where the areas to be lightened are relatively limited, requires masking of those areas not to be etched. The proper technique, of course, can only be decided on the basis of the individual part.

Since the success of chemical milling depends to a considerable extent on the soundness of the casting itself, Rolle cannot promise satisfactory results on any but a Rolle cast part. But Rolle will gladly examine your prints and parts in light of this new technique and make recommendations or quote prices, as you desire. Furthermore, we'll be happy to answer any further questions you may have relevant to chemical milling or the sand, permanent mold, shell mold, or investment casting of aluminum or magnesium alloys. Write Rolle Manufacturing Company, 309 Cannon Avenue, Lansdale, Pa., or call ULysses 5-1171.

ROLLE

F-104A Carries Jettisonable Pylon Fuel Tanks

First photo reveals jettisonable 200-gal. fuel tank carried under each wing of Lockheed F-104A. Pylon attachments are jettisonable. Tanks are 17 ft. 6 in. long, have mid-diameter of 20.5 in. Fins on tank tails increase stability. F-104A is powered by General Electric J79 rated at 12,000 lb. thrust. Fighter is 54 ft. 9 in. long, 13 ft. 6 in. high, has 21 ft. 11 in. wingspan (AW Jan. 21, p. 30).

WHAT'S NEW

Reports Available:

The following reports were sponsored by The Office of Technical Services, United States Department of Commerce, Washington 25, D. C.

Development of Schematic Analytical Procedures for Synthetic Lubricants and their Additives: Part 3—by F. S. Bonomo, Denver Research Institute for Wright Air Development Center: $1.50; 56pp.; (PB 131063).

The Effects of Nuclear Radiation on Military Specification Greases: Part 1—by W. L. R. Rice, Wright Air Development Center, U. S. Air Force, December 1956: $.75; 29pp.; (PB 121914).

Heat Capacities of Synthetic Engine Oils and Lubricants—by H. Marcus, Wright Air Development Center, U.S. Air Force, April 1957: $.50; 14pp.; (PB 131038).

Strength and Corrosion Resistance of Ultrasonically Soldered Aluminum Joints—by J. B. Jones and J. G. Thomas, Aeroprojects, Inc., for Frankford Arsenal, U.S. Army, March 1956: $1.75; 61pp.; (PB 121965).

Study, High Performance Cabin Cooling Unit—by A. P. Lane, Fairchild Engine and Airplane Corp. for Wright Air Development Center, U.S. Air Force, October 1954: $4.00; 159pp.; (PB 121284).

Ultrasonic Welding of Metals—by J. B. Jones, C. F. DePrisco and J. G. Thomas, Aeroprojects, Inc., for Frankford Arsenal, U.S. Army, April 1955: $2.75; 105pp.; (PB 131084).

The Application of Ultrasonic Energy to Cold Welding of Metals—by J. B. Jones and C. F. DePrisco, Aeroprojects, Inc., for Frankford Arsenal, U.S. Army, November 1953: $1.75; 61pp.; (PB 131083).

Mechanical Properties of Unalloyed Chromium—by S. A. Spachner and W. Rostoker, Armour Research Foundation for Wright Air Development Center, U.S. Air Force, December 1957: $2.00; 74pp.; (PB 121895).

Research on Elevated Temperature Resistant Inorganic Polymer Structural Adhesives: Part 2—by H. H. Levine, Quantum Inc., for Wright Air Development Center, U.S. Air Force, November 1956: $.75; 30pp.; (PB 121908).

Publications Received:

Sixth Symposium on Combustion—by The Combustion Institute—Pub. by Reinhold Publishing Corp., 430 Park Avenue, New York 22, New York. $28.00; 943 pp.

This book contains an invaluable and stimulating source of new data, information on theoretical concepts, and principles of engineering applications for those working on the many aspects of combustion.

Civil Air Regulations and Flight Standards for Pilots—by Associated Aeronautical Staff—Pub. by Publishers, Inc., 2162 Sunset Blvd., Los Angeles 26, California. $2.25; 160pp.

This volume contains the new "Cross-Country, Typical Examination for Private Pilots," important Civil Air Regulations that all pilots must know and abide by, plus pages of standard practices, procedure and information.

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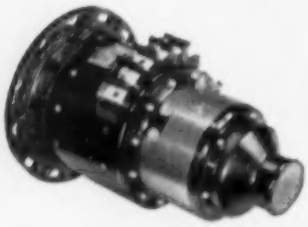

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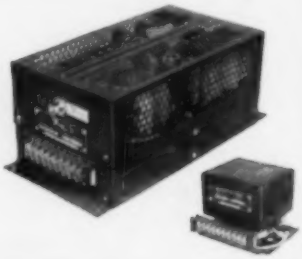

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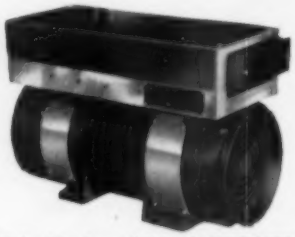

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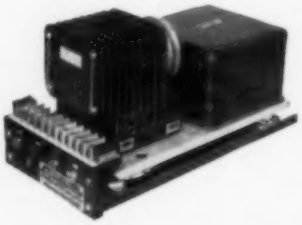

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Technique May Offer 1,400C Transistor

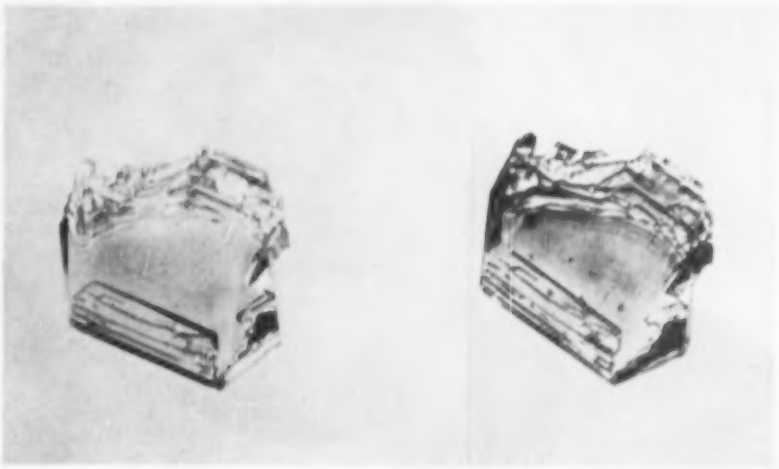
By James A. Fusca

Bedford, Mass.—Transistors that will operate to temperatures of 1,400C and frequencies above 100 mc. have become a significant possibility as a result of new techniques developed here at Air Force Cambridge Research Center for producing diffused semiconductor junctions in crystals of silicon carbide.

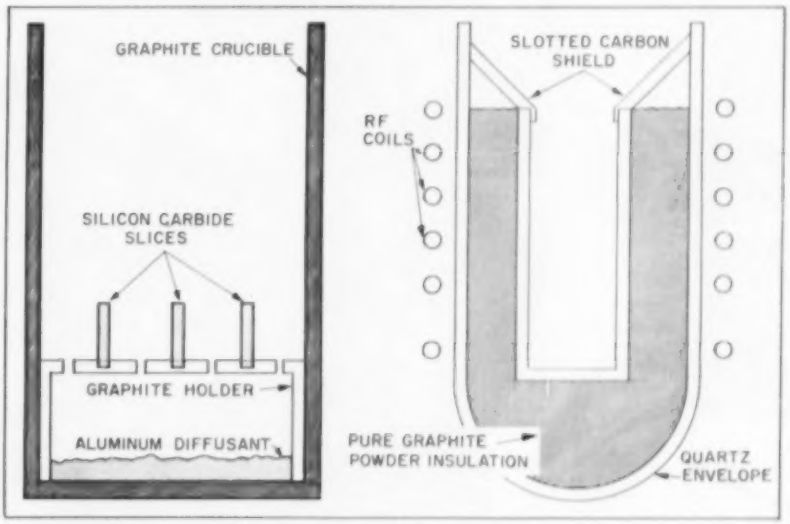
This temperature is five to six times higher than present day semiconductor operating temperatures and opens the way to high temperature applications such as avionic equipment for missile warheads without special cooling now needed.

Semiconductor research with silicon carbide is not new. Work with this material was first reported in Germany about five years ago. The Air Force Cambridge Research Center technique, however, is the first report of the successful production of junctions by solid state diffusion which is generally considered to be the most promising technique in terms of frequency, reproducibility and simplicity.

In addition to work being done in its own laboratories, the Cambridge Research Center has research contracts outstanding with Westinghouse and Armour Research for the study of silicon carbide semiconductors. Other companies studying the material at present include: General Electric, Shockley Semiconductor Laboratory and Texas Instruments.



UNTREATED CRYSTAL of light green, n-type silicon carbide appears at top left. Same crystal as it appears after furnacing is shown at top right. A p-type outside layer has been created by the diffusion of aluminum into the crystal lattice, which gives it a bluish cast. Crucible (bottom left) holds crystals during diffusion run in 20 kw. r-f furnace (bottom right).



Work Needed

All parameters of silicon carbide as a semiconductor material and of the various techniques for producing junctions in the material have not yet been explored. An Air Force Cambridge Research Center spokesman told Aviation Week that work to date has proved only the basic feasibility of their method and that much arduous and time-consuming work remains before application of these devices to avionic equipments.

The view was expressed, however, that the program had progressed to the point where more manpower and additional laboratory facilities could greatly speed this remaining work.

First information on this research was contained in a paper delivered recently at the Semiconductor Device Research Conference at Boulder, Colo., by Miss Miriam T. Minamoto, Cambridge Research Center physicist.

Quoted maximum operating temperature of 1,400C for silicon carbide semiconductors appears reasonable. Resistivity of the material plotted against temperature does not show a significant decrease, or roll-off, below 1,600-1,700C.

In conventional germanium and silicon semiconductors, normal p-n junctions are produced by one of three means: by growing, by alloying or by solid state diffusion. The solid state diffusion method is the most recently developed and has the advantage of permitting close control of the base layer width which, among other factors, determines the upper frequency limit of the device.

Both Air Force Cambridge Research Center and Westinghouse have produced p-n junctions in silicon carbide crystals, the Center by solid state diffusion techniques and Westinghouse by the grown junction method. These devices have been operated in the laboratory to temperatures of about 700C. Difficulties encountered at these temperatures were:

• **Contacts and leads.** Problem of fail-

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MANEUVERING above 100,000 feet, pilots will face problems never before encountered. Rudders and ailerons will be ineffective in the rarefied air. Reaction controls such as rockets strategically located and automatically controlled will be needed. Also, high Mach numbers and low static pressures will make the measurement of air data quantities inaccurate. Yet conventional autopilots rely on this data. Another problem: many situations at high altitude and high speed happen too fast for human control. How can reactions to these be performed automatically? The answer to these problems depends on the development of a new type of flight control system. This system will not only operate the aerodynamic and reaction controls, but, being an adaptive system, it will not require air data measurements. Honeywell is making rapid progress toward development of such a system.

Honeywell's vast experience in flight control systems, instrumentation and engine controls makes it the logical company, not only to do this advanced work, but also to aid you in your airborne control problems. Contact Minneapolis-Honeywell, Aeronautical Division, 2600 Ridgway Road, Minneapolis 13, Minnesota.

Will a plane such as this reach 250,000 ft.? In this artist's conception, reaction controls which port high energy gas from small rocket motors are located at wing tips and nose. Control is produced by generating angular accelerations in roll, pitch and yaw. Development of an automatic control system for this type of reaction control is now actively in progress at Honeywell Aero.

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AMERICAN BOSCH ARMA CORPORATION

ures with leads and contacts was found at temperatures near 700C. This problem is not considered critical in that there are several promising approaches to its solution. One method is the use of ultrasonic soldering—a technique originally developed for the soldering of aluminum—which forces the solder through the oxide layer always present on the semiconductor surfaces. Another is the thermal-compression bonding method reported by Bell Telephone Laboratories (AW July 29, p. 80).

• **Impurities and imperfections.** Commercially available crystals of silicon carbide tend to be highly contaminated. Not only do these impurities affect the diffusion process, but also the minority carrier lifetime which in material of this type is the basic parameter determining conventional transistor gain. Techniques used in purification of silicon are being explored here.

Metallurgical Problem

Basic problem remaining to be solved is metallurgical. Silicon carbide as presently available does not approach the purity and crystalline regularity that is required for conventional transistors.

For transistors made of a material such as silicon carbide, the basic parameter determining the gain is purity because this determines the minority carrier lifetime.

At Air Force Cambridge Research Center, work is being done to obtain a high degree of purity from commercial-grade material. The process involves resublimation of the original crystals and building up of new crystals by vapor deposition. There are a number of problems with this technique because the crystals, to be useful, must not only be without chemical contamination but must also have a physically perfect crystallographic structure.

This problem was partially solved for silicon semiconductors with the development of the so-called floating zone technique. In this process, a rod of pure silicon is heated to the melting point at one end by inductive heating. The width of the melted zone is carefully controlled as the heating unit passes along the rod so that surface tension can hold the rod together. The silicon is then allowed to cool and develop its natural crystal structure without contact with a contaminant such as a crucible.

Frequency Limit

One problem that must be solved before silicon carbide's high frequency limit can be estimated (for conventional transistors) is the determination of drift mobility of carriers in the material.

The ability of a material to preserve its electrical characteristics at high temperatures is a function of the width of its energy gap. This energy gap is the energy required to break a valence bond in the material and liberate a pair of electrical charge carriers.

Usually, materials with wide energy gaps such as silicon carbide have a consequently lower carrier drift mobility, therefore a lower frequency limit. This is not, however, an invariable rule and no accurate frequency limit estimate can be made until the specific drift mobility of this material is determined in the laboratory.

Performance of laboratory diodes made of silicon carbide presently is considerably below that of commercial silicon diodes at normal temperatures. For example, a forward to reverse current ratio, at five volts, of 10^6 is given by Cambridge Research Center for silicon carbide, compared with a value of 10^7 for conventional silicon diodes.

The significance of the work, however, is that these devices have operated at 700C and are apparently capable of operating at much higher temperatures. There is little doubt that on the basis of this one characteristic extensive efforts will be made to improve the electrical characteristics of these devices in the same way that silicon semiconductors have been improved over the past several years.

Useful silicon carbide transistors

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Waugh model MF-142 totalizing turbine flowmeter has been selected for the tanker version of the *Douglas A3D Skywarrior* to give precise measurement and control of fuel transfer.

FEATURES:

- Simple, reliable transistor circuitry in flow sensor actuates counter and signal light—no intermediate devices
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LINDSAY PRESSURE GAUGE used in jet aircraft. Model #6907-1 shown here in actual size; total weight .20 pounds. (Other models for missiles and special applications.)

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designed for jet pressure systems

The RMC-Lindsay Pressure Gauge for jet aircraft is made for extensive cycling—will meet rigid endurance and over-pressure requirements. Not even the most extreme conditions of shock, vibration or temperature disturb its accuracy. Pressure ranges from 1,000 to 15,000 psi.

The RMC-Lindsay Gauge is a bourdon tube type, using a multiple coil, helical bourdon tube with the pointer attached directly to the end of the coil. The life of the Lindsay helical bourdon coil, as compared to the traditional "C" spring bourdon gauge, is more than 10 times greater and its proof pressure limits are increased by a factor of 3 or 4. The helical bourdon tube also eliminates the use of linkages and pivots, improving the gauge's shock resistance by a factor of 5 or 10.

The helical bourdon element is, of course, not a new development. However, the RMC-Lindsay techniques in coiling, heat treatment, calibration and material specifications *are* new—and exclusive with RMC.

Whatever your high pressure gauge problems may be, why not let RMC engineering skill provide the answers. Write to either of the below addresses, outlining your particular requirements.

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RMC
LINDSAY PRESSURE GAUGES

may depend upon the development of unconventional techniques. For example, one approach to the problem of obtaining pure silicon carbide might be through the combination of pure (elemental) silicon and carbon.

Another approach might be to accept the impurity of presently available silicon carbide and attempt to develop devices that will operate within this limitation. Such devices might take the form of the unipolar transistors developed by Dr. William Shockley (the field-effect and analog transistors discussed by him in Proceedings of the Institute of Radio Engineers, November, 1952).

The advantage of these unipolar devices is that they depend only on majority carrier transfer, where conventional bipolar transistors depend on transfer of both majority and minority carriers. Because majority carrier transfer is not inhibited by impurities to anywhere near the same degree as minority nority carriers, these devices appear to offer one practical approach.

Artificial Meteors Produce Ionosphere

Bedford, Mass.—Air Force has revealed that recently fired artificial meteors produced an artificial ionosphere capable of reflecting radio waves for almost one hour, opening the way to extremely long-range transmission of VHF radio waves for communications, ballistic missile guidance or telemetry and even intercontinental television.

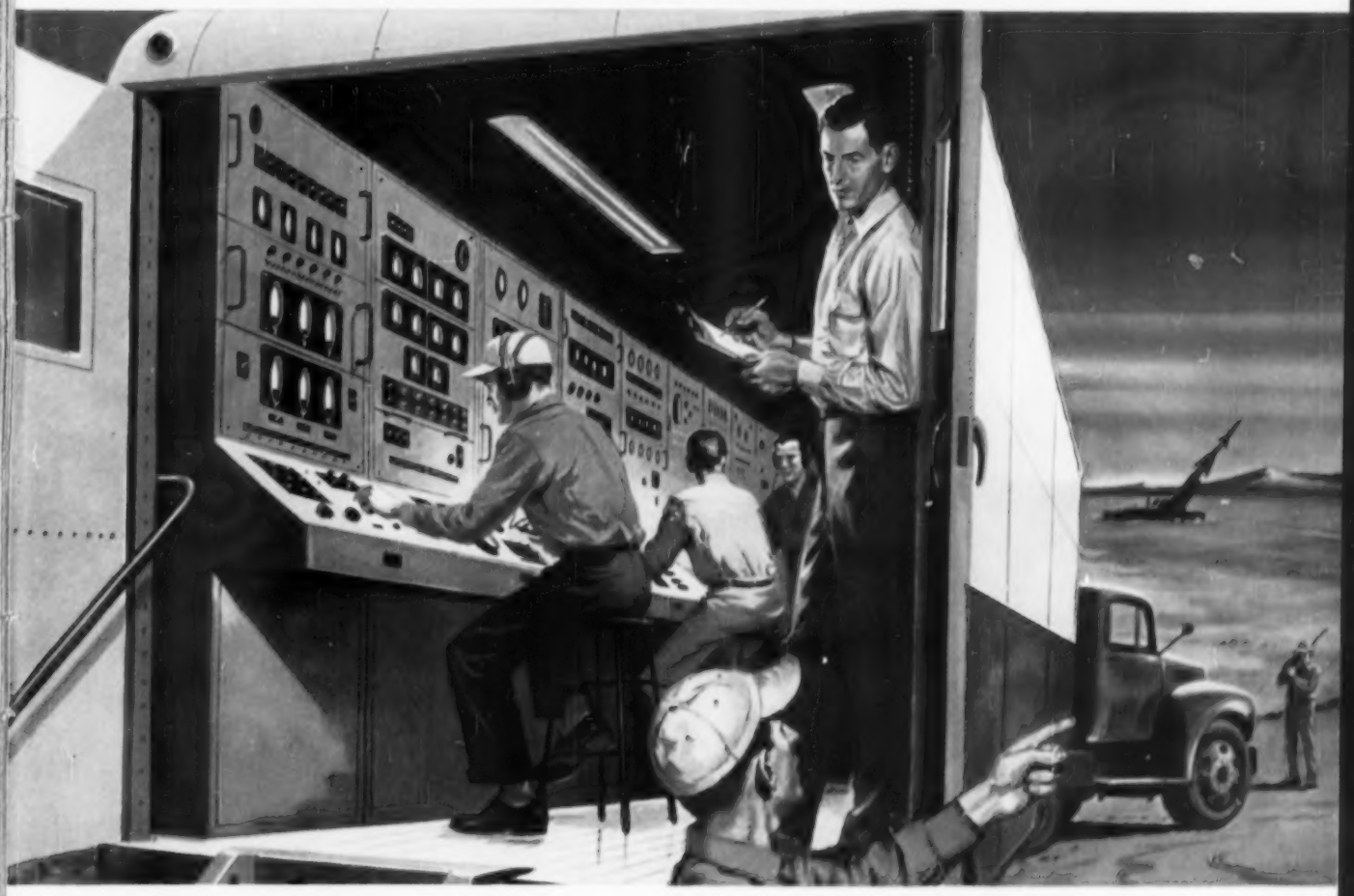
Artificial electron cloud was created at an altitude of about 75 mi., between "E" and "F" layers of the ionosphere, Air Force Cambridge Research Center reports, adding that the electron cloud was both persistent and intense.

Transmission ranges of 1,400 mi. at VHF frequencies recently have been achieved by bouncing radio signals off the ionized trails produced by natural meteors (AW June 17, p. 96). Natural meteor trails, however, last for only a couple of seconds, requiring intermittent high-speed transmissions only when a natural meteor trail is available. Ability to produce an artificial electron cloud at will provides far greater operational flexibility and perhaps greater usable bandwidth.

Cambridge reports that additional experiments are scheduled as part of its Operation Smokepuff to more fully explore the possibilities of the new technique.

Maximum frequency of radio signals bounced off the artificial meteor trails has not been released. Stanford Propagation Laboratory and several hundred radio amateurs throughout the Southwest participated in the initial experiment, Cambridge reports.

If your problem calls for
MISSILE GROUND SUPPORT



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Link's capabilities in the field of electronic ground support have been established through the actual design and manufacture of precise electronic units delivered to satisfied customers.

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Soon to be flying the nation's airways is the Lockheed Electra—a medium range, high-speed, prop-jet transport. Wing Flap Actuators for this nimble, fast climbing plane are being manufactured by the Speco Aviation Division of Kelsey-Hayes.

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DIGITAIR, airborne digital computer now in production, performs target intercept, navigation and flight control functions in F-106.

BUILT-IN test provisions permit speedy checkout of digital computer before each flight.

COMPUTER'S magnetic memory drum, undergoing balancing above, can store 3,896 19-digit words.

F-106 Computer Navigates, Intercepts

New York–Digitair, lightweight airborne digital computer which will perform target interception, navigation and flight control computations in the Convair F-106, was shown here for the first time by Hughes Aircraft which developed the computer as part of its F-106 integrated avionics package.

Hughes says the unit is the first airborne digital computer to go into production. It weighs 120 lb., occupies a volume of approximately four cubic feet.

Present model uses vacuum tubes but Hughes has a transistorized version under development.

Digitair is an outgrowth of the Hughes Digitac, the nation's first airborne digital computer to undergo flight evaluation, whose development was begun in 1948 (AW May 10, 1954, p. 62). Current model has undergone more than 1,100 hr. flight test in a T-29 and an F-102, according to John A. Rubel, director of Hughes' airborne systems laboratories.

Performs Many Functions

Digitair is designed to provide automatic navigation of the F-106 to the target area by means of ground-transmitted data link commands, ground-based Tacan signals, or dead reckoning if the former are not available. Computer develops steering commands for the autopilot and display information for the cockpit radar scope, Hughes says.

When interceptor is close enough to target for its own airborne radar to lock onto the target, Digitair switches over to use radar data to compute steering commands and display information. Computer also determines when air-to-air missiles should be lowered into firing position, armed and fired, and accomplishes these operations automatically. After the attack, computer again takes over and flies interceptor back to original or alternate base.

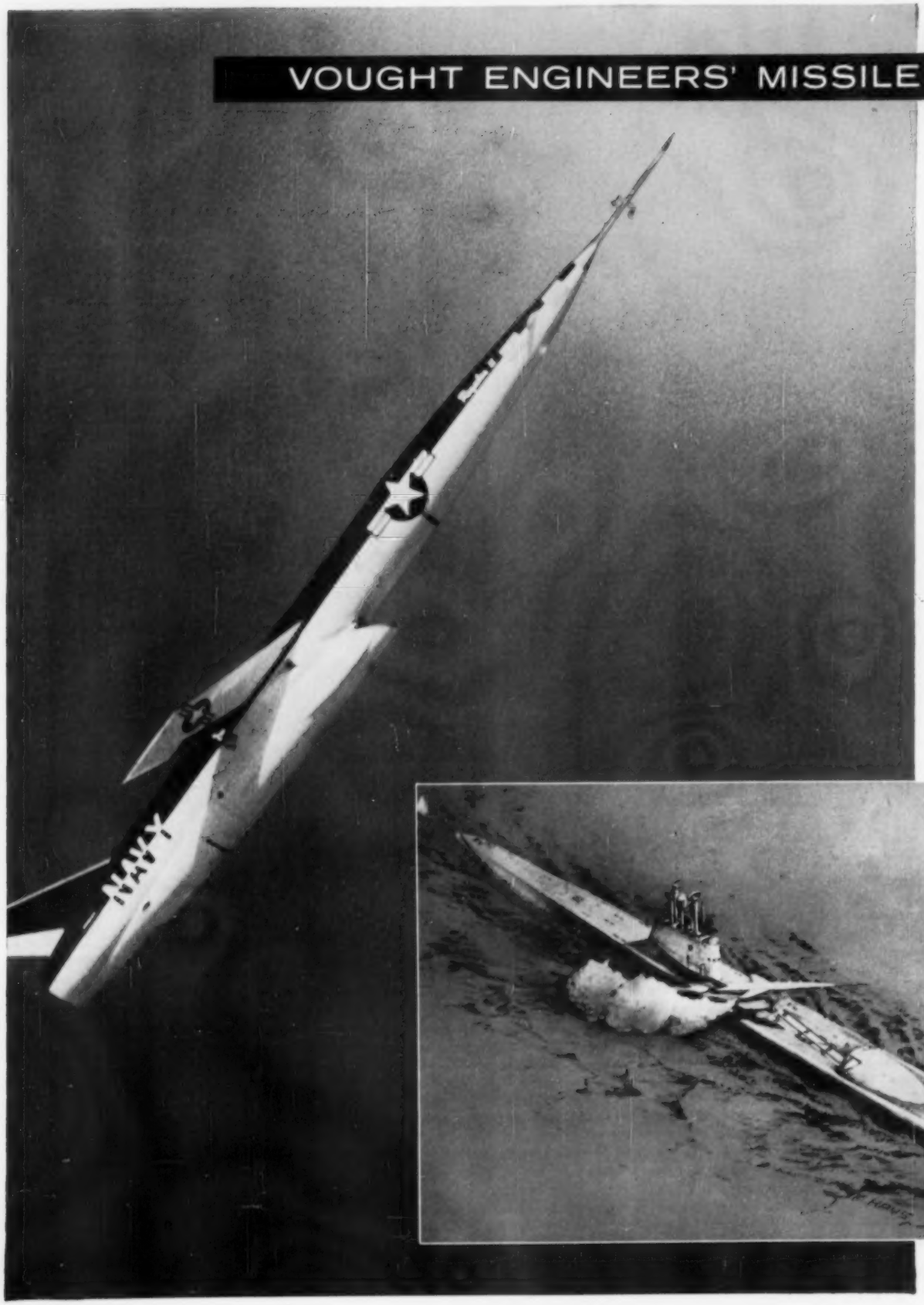
Hughes says Digitair can be used in bombers to provide automatic navigation, target approach, bomb release, flight control and evasive maneuver functions and to direct defensive armament. Company also suggests possibility of using Digitair in new jetliners to provide automatic navigation, optimum cruise control and flight control functions.

However, Rubel says company is not actively working on this application at present.

Digitair Characteristics

Hughes Digitair is a general purpose computer, employing a clock rate of 160 kc., a modified two-address system of commands and a word length

VOUGHT ENGINEERS' MISSILE



SYSTEM ARMS NEWEST NUCLEAR SUB

Regulus II–Massive Air Power For Navy's "Undersea Satellite"

Construction has begun on the *USS Halibut*, world's first missile-carrying nuclear submarine. Meantime, the *Halibut's* primary weapon — Vought's Regulus II missile — is being flown repeatedly as a supersonic flight test vehicle.

Before long the two will be joined — a *true* submarine with unlimited undersea range and a far-flying missile, ready to deliver a nuclear strike. You'll hear more about this "undersea satellite" when it begins its stealthy orbit through the deep waters of the world.

Right now — as a Vought engineer — you can help bring it into being.

Chance Vought has weapon systems responsibility for mating its missile with the atomic sub. Today, Vought engineers are designing the *Halibut's* missile support equipment. They'll help train submariners for Regulus II operation, and they'll be on board for check-outs of the entire missile system.

Vought engineers introduced missile power to the Undersea Fleet with Regulus I. In the process, they traveled a new and exciting development route . . . from test range to shipyard to shakedown cruise.

Join them this time and share their adventure. Help forge from sea and air power an *ultimate* weapon.

USS Halibut symbolizes advanced capabilities of the Navy's 57-year-old submarine force and signals a broad new frontier for weapon systems engineering at Chance Vought.

Now, inertial guidance for sea-going missiles

A new kind of guidance system is under development for *Regulus* missiles. It's being designed to provide longer-range guidance and finer terminal accuracy. It will be able to handle quick changes in launching position and variations in course. It must meet these rigid requirements in order to guide ship-based missiles.

This *Regulus* sea and air venture demands systemization of components much more sensitive than present-day guidance requires. It involves advanced development facilities: flight test aircraft instrumented for inertial guidance, and the Navy's extensive equipment for navigation research.

It's a unique new challenge for Vought engineers who will direct all development, design, systems work, and flight and sea tests.

Scientists and engineers: pioneer with Vought in new missile, manned aircraft, and electronics programs. For details on select openings write to: C. A. Besio, Supervisor, Engineering Personnel, Dept. A-25.

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Star track photograph created by time exposure of film while camera was focused on Polaris.

WHAT IS SPACE?

Some 500 miles above the earth, a few solitary molecules of atmosphere are the final "land's end" of our small island in space—the outer reef beyond which lies an immense cosmic ocean so inconceivable that men had to invent a symbol (∞) to denote it.

How vast is this ocean, and what lies beyond our shores?

First, our own sea of stars: This is a giant wheel-shaped galaxy containing some 300 billion stars. Imagine a speck the size of a dust particle on the spoke of a cosmic carriage wheel 1,000 miles in diameter. This is the relative size of our sun, one small life-giving star in the great procession. And beyond our galaxy, at least 100 million more such galactic systems are telescopically visible.

The "weather" of this cosmic ocean is composed of strange storms of cosmic radiation, distant clouds of interstellar gas, violent geomagnetic tides and currents, sudden showers of meteoric dust.

It is this weather that we first seek to understand. Much needs to be learned about cosmic rays, the nature of gravity, the physics of light, the true chemistry of "nothingness," the temperature of space, and the movements of the atmosphere on our small island below.

Our first few hundred miles voyage into space will be an infinitessimal step into the 600 billion billion miles of the visible eternity surrounding us.

MARTIN

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of 16 bits plus sign. Memory drum, which rotates at 8,000 rpm., has a storage capacity of 3,896 19-digit words. Computer can perform 48 different operations: eight arithmetic operations, 36 transfers and four logical choice and miscellaneous.

Digitair can perform 9,600 additions or subtractions per second, 600 multiplications, divisions or square root extractions per second, Rubel reports.

In the F-106 avionic system, Digitair samples 33 analog and 28 digital inputs per second, calculates total of 14 analog and 16 digital outputs per second. Digitair performs all required analog-to-digital and digital-to-analog conversions.

Expansions, Changes In Avionics Industry

Data-Control Systems Inc., Danbury, Conn., is name of new company which will develop and manufacture instrumentation, control, computation and data handling systems. Dr. Robert J. Jeffries is president. Company address: 39 Rose St.

Other recently announced changes and expansions in the avionics field:

• **General Atronics Corp.**, Bala-Cynwyd, Pa., has formed new affiliate known as **Atronic Products Inc.** to produce equipment developed by the parent company. One of the first products will be an automatic sequential tester for checking printed circuit cards on a production line. Company address: 1 Bala Ave.

• **The Single Crystal Corp. of America** is name of new firm which will grow crystals of various materials for electronic, optical and nuclear applications. Company address: Saxonburg Blvd., Saxonburg, Pa.

• **The Carborundum Co.** will combine its Stupakoff Division at Latrobe, Pa., Globar Division at Niagara Falls, N. Y., and its Refractories Division, Perth Amboy, N. J., into single division to be called the Refractories Division. Boyd M. Johnson, vice president, is named general manager of new division.

• **Magnetic Research Corp.**, Hawthorne, Calif., has formed new Stablvolt Division to manufacture new line of d.c. power supplies. C. T. Davis is manager.

• **Control Data Corp.**, Minneapolis computer development firm, has purchased Cedar Engineering, Inc., electronic manufacturing company also of Minneapolis, through a stock exchange. New acquisition occupies 33,000 sq. ft. plant and employs 165 people. E. J.

Guiding a missile, or speeding flight and flight environmental data back to control and tracking centers, is too much of a job for conventional communication systems. Supersonic speeds call for lightning fast data communications, coupled with the utmost reliability.

Capitalizing on the ease of converting messages into digital form, Motorola scientists and engineers have developed a number of Data Link Communications Systems suitable for piloted aircraft, as well as missiles.

NERVE CENTER FOR DATA LINK SYSTEMS

With Data Link Systems, messages that have been translated into on-off pulses can be transmitted by any of the common modulation schemes with a suitable carrier. The transmitter can be air-borne, ship-borne, or land-based. Received messages are amplified, decoded, and transformed into a form suitable for display, or stored for some future time, or used for direct control through auto pilots, for example.

One of the Data Link Systems designed at Motorola utilizes an all-transistor converter-coupler, packaged in modular form. The total system consists of eight modules, each approximately 4" x 8" x 1½". The fully transistorized circuitry is of the highly reliable diode-matrix type logical circuitry used in many digital computers. The switch type transistors employed are a product of the Motorola Semi-Conductor Division. Indicative of the stringent testing program to which the transistors are subjected is a 1000-hour life test at 85° C.

For another Data Link program, Motorola has designed a system featuring resolver-type outputs. A single time-shared servo amplifier positions anyone of the five resolvers in accordance with commands from the ground transmitter.

These two Motorola Data Link Systems aimed at solving one of the important communication problems of the missile age are examples of the complex programs conducted by Motorola for varied military needs.

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Positions open to qualified Engineers and Physicists

Manning, former president of Cedar Engineering, becomes vice president of Control Data Corp. and general manager of new division.

• **Raytheon Manufacturing Co.** has opened new 42,000 sq. ft. laboratory in Santa Barbara, Calif., which will specialize in infrared, countermeasures, communications and radar development. Laboratory employs 150 persons.

• **Offices of Wescon,** Los Angeles section of **Institute of Radio Engineers** and **West Coast Electronic Manufacturers**

Assn., will move to larger quarters at 1435 So. LaCienega Blvd., Los Angeles, on Dec. 1.

• **Lear** announces that the sales and service activities of its Swiss subsidiary, **Lear S.A.** of Geneva, have been sold to new Swiss firm, **Electravia S.A.** of Geneva, which will handle Lear products in Switzerland.

• **Consolidated Avionics Corp.** will move to new 20,000 sq. ft. facility in Westbury, N. Y. Industrial Park in January. Company manufactures automatic test and data reduction equipment.

• **Howard Industries Inc.,** Racine, Wisc., has purchased **Westinghouse** Electric's Universal Motor Division, whose machinery and equipment will be moved from Lima, Ohio, to Howard's plant in Racine.

• **Mack Trucks Inc.,** Plainfield, N. J., has combined all its electronic activities into a single division to "permit a greater coordination of effort" in the avionics field. Manufacturing operation will remain in Plainfield and research and development in Boston, but will report to single division chief, Robert Edwards.

• **General Transistor Corp.** has leased an additional 16,000 sq. ft. of facilities in Richmond Hill, N. Y. Company now has five factories in the New York area.

• **Fischer & Porter Co.,** maker of process instrumentation systems, has relocated its Chicago branch factory at 1205 So. 8th Ave., Maywood, Ill., a Chicago suburb.

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ELECTRICAL CHARACTERISTICS		Other Oster Resolvers					
Size	*15	10	10	11	15	15	15
Rotor—(No. wires/No. phases)	4/2	3/2	2/1	3/2	3/2	2/1	3/2
Input voltage (to rotor) (Volts)	16	26	26	26	26	26	7.45
Stator—(No. wires/No. phases)	4/2	4/2	4/2	4/2	4/2	4/2	4/2
Input voltage (to stator) (Volts)	16	11.8	11.8	11.8	11.8	18	26
Rotor current (stator open) (Milliamperes)	14	29	9.2	46	52	11	38
Rotor power input (stator open) (Watts)	.03	.29	.06	.27	.2	.09	.05
Stator current (rotor open) (Milliamperes)	13.5	49	15.3	78	91	12.6	12.4
Stator power input (rotor open) (Watts)	.05	.18	.05	.16	.17	.06	.08
Zro	139 +J 1134	352 +J 843	753 +J 2740	127 +J 550	72 +J 497	831 +J 2381	37 +J 194
Zso	254 +J 1160	79 +J 231	261 +J 1727	26.4 +J 149	21 +J 128	351 +J 1385	588 +J 2060
Rotor D.C. resistance per phase (Ohms)	70	240	450	75	55	375	22
Stator D.C. resistance per phase (Ohms)	175	44	165	16	14	160	206/408
Rotor output voltage per phase (stator excited) at maximum coupling (Volts)	14.9	19.7	20.3	19.5	20.7	21	7.45
Stator output voltage per phase (rotor excited) at maximum coupling (Volts)	15.3	11.8	11.8	12.6	11.8	17.8	26.2
Voltage gradient (stator) (Millivolts/degree)	268	206	206	220	206	310	458
Phase shift (rotor to stator)	2.3°	14.6°	6.8°	6.3°	6.8°	7.28°	4.56°
Phase shift (stator to rotor)	8.1°	9.4°	10.6°	4.8°	6.5°	5.47°	4.6/9.8°
Null (residual voltage) Total R.M.S. (Millivolts)	(Quadrature)	50	30	30	50	40	40
Fundamental (Millivolts)	12% of input voltage	35	21	21	35	28	28
Angular accuracy	Functional error: 14% of input voltage	24' spread	24' spread	10' max.	20' spread	20' max.	45' max.
MECHANICAL CHARACTERISTICS Friction at +25°C (Gcm)	22	5	5	4	5	10	10
at −55°C (Gcm)	45	15	15	16	15	30	20
Weight (Ounces)	8.0	1.75	1.75	3.0	5.0	5.0	5.0
Leads (color coded) (Number/length)	TERMINALS	(7)-12"	(6)-12"	(7)-12"	(7)-12.5"	(6)-12"	TERMINALS
OSTER type number	*15-4042-06	10-4061-01	10-4065-02	11-4117-03	15-4011-02	15-4015-04	15-4043-02

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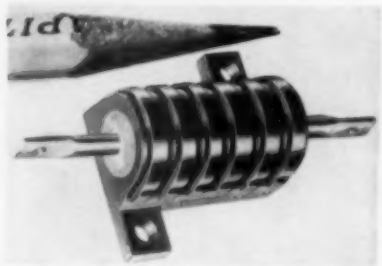
Components & Devices

• **Subminiature 10 w. resistor,** Type RH-10, is available in tolerances from ±0.05% to ±3% with a resistance range from 0.05 to 30,000 ohms, depending on tolerance specified. When panel-mounted on aluminum, RH-10



will dissipate 10 w., derated to zero at 275C. Free air rating is 6 w. RH-10 is one of a series of resistors rated from 10 to 250 w. Request Bulletin R-21E. Dale Products, Inc., Columbus, Nebraska.

• **Diffused base silicon transistors,** Types 2N497 and 2N498, are rated at 4 w. to bridge the gap between commercially available low power and high power transistors. Four watt rating is at 25C case temperature, derates to one watt at 150C. Both are npn type transistors with a typical saturation resistance of 20 ohms at 25C. Operating range is −65 to 200C. Packaged in short, round welded cases, they differ from each other only in collector-to-base and collector-to-emitter voltage ratings. The 2N497 is rated at 60 v., 2N498 at 100 v. Texas Instruments, Inc., Box 312, Dallas.

• **Miniature twin triode,** Type CK5687-WA, meets military specifications and is suited for pulse and servo driver applications. Tube is said to have high emission capabilities, high perveance, medium mu (18.5), and controls for plate emission as well as for minimum formation of cathode interface resistance. Cathode current maximum for each section is 65 ma. dc. and total

New Thermocouple Measures Up To 3600° F.

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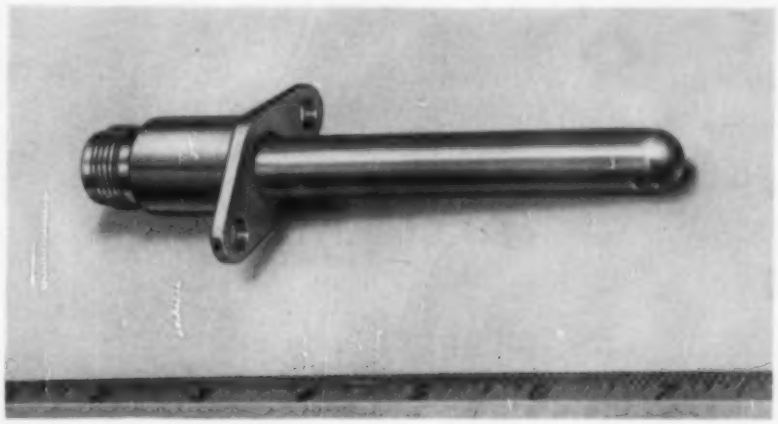


A new, high temperature thermocouple probe, developed by Thermo Electric, promises to solve several serious problems of airborne or test stand temperature measurement. This probe was designed for use in the high velocity gas streams of jet engine afterburners, and ramjet and rocket exhausts. The key to its performance is a cermet (ceramic-metal combination) support tube and radiation shield.

This support tube replaces the need for water or air cooling. As a direct result, conduction errors due to cooling are eliminated and radiation losses to cold duct walls are reduced about 60%. Other disadvantages of water cooling—water supply, conduit, additional space needs, and other installation difficulties, are also eliminated. Equally important are the probe's conductors—Platinum 6% Rhodium/Platinum 30% Rhodium up to 3000°F. and Iridium/Iridium Rhodium up to 3600°F.

Thermo Electric's initial objective with this probe was a life in excess of five hours at temperatures of 3000°F. or higher. It has already been tested at 3000°F. in a Mach 1 gas stream for 1½ hours without failure. Tests are still under way to determine the ultimate operating limitations of the probe's structural elements.

Other Applications

Possible applications of this type of unit, however, are much wider in scope. Both construction and conductors can be varied to meet a great variety of temperature measuring problems. The support tube itself, for example, can be formed to almost any shape. Other tube materials are also being investigated.

If you'd like further information on this thermocouple and how it can be adapted to your particular needs, contact Thermo Electric. Its development is typical of T-E's continuous progress in the field of high temperature measurement. Our extensive research and engineering facilities provide a complete service for the aircraft industry. Call on us. The answer to your problem may be waiting for you.

"Progress That Anticipates Progress"

Thermo Electric Co. Inc.
SADDLE BROOK, NEW JERSEY
In Canada
THERMO ELECTRIC (Canada) LTD.
Brampton, Ontario

World's newest and fastest

Time: 9 December, 1957.

Occasion: the Eastern Joint Computer Conference in Washington.

Event: a major breakthrough of speed, quality, flexibility and cost reduction in the field of data processing and transfer.

Featured: the new device pictured above.

Known as the "Stromberg-Carlson Model 5000 High-Speed Electronic Printer," this equipment combines CHARACTRON® computer read-out tube, made by Stromberg-Carlson, and XEROX® COPYFLO® electronic printer, made by Haloid. Together, they translate stored electronic information into visual material —at 5 to 10 times the volume output of mechanical printers representing the same investment.

In operation, the CHARACTRON shaped-beam tube reads out and displays on its face the output of any data processing equipment—at speeds up to 10,000 characters a second. Acting electrostatically and with *dry* materials, these displays sensitize the surface of a selenium drum in the XEROX COPYFLO printer. The data are then transferred to a roll of paper, vellum or multilith master and come off the printing machine at the rate of 5,400 pages an hour!

Besides speed, many other advantages are inherent in the system. There is no intermediate processing, as with engraving or letterpress—*lower cost per page!* Manufacture of the "Model 5000" utilizes printed circuitry and transistors—*dependability!* Texts, graphs and business forms can be combined—*flexibility!* And computers whose idle time may be valued at as much as $300 an hour can be "emptied" in just minutes—*efficiency!*

We are confident that this system is the answer to hundreds of electronic data processing output problems, military and commercial. Inquiries should be addressed to Stromberg-Carlson, San Diego, Calif.

S-C

STROMBERG-CARLSON

A DIVISION OF GENERAL DYNAMICS CORPORATION

General Offices and Factories at Rochester, N. Y.—West Coast plants at San Diego and Los Angeles, Calif.

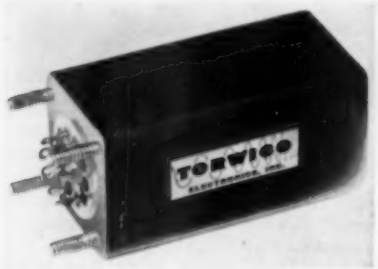
GD

allowable dissipation for both plates is 7.5 w.

Raytheon Manufacturing Co., 55 Chapel St., Newton 58, Mass.

• **Miniature magnetic amplifier** and relay unit, called Tinymag, will operate positively on a 25 microwatt input signal, eliminating the need for preamplifiers.

Relay will accept unfiltered d.c. signals directly from a thermocouple, resistance bridge, photocell or synchro. Unit is said to operate at full sensitivity in a 40G shock, 20G vibration environ-



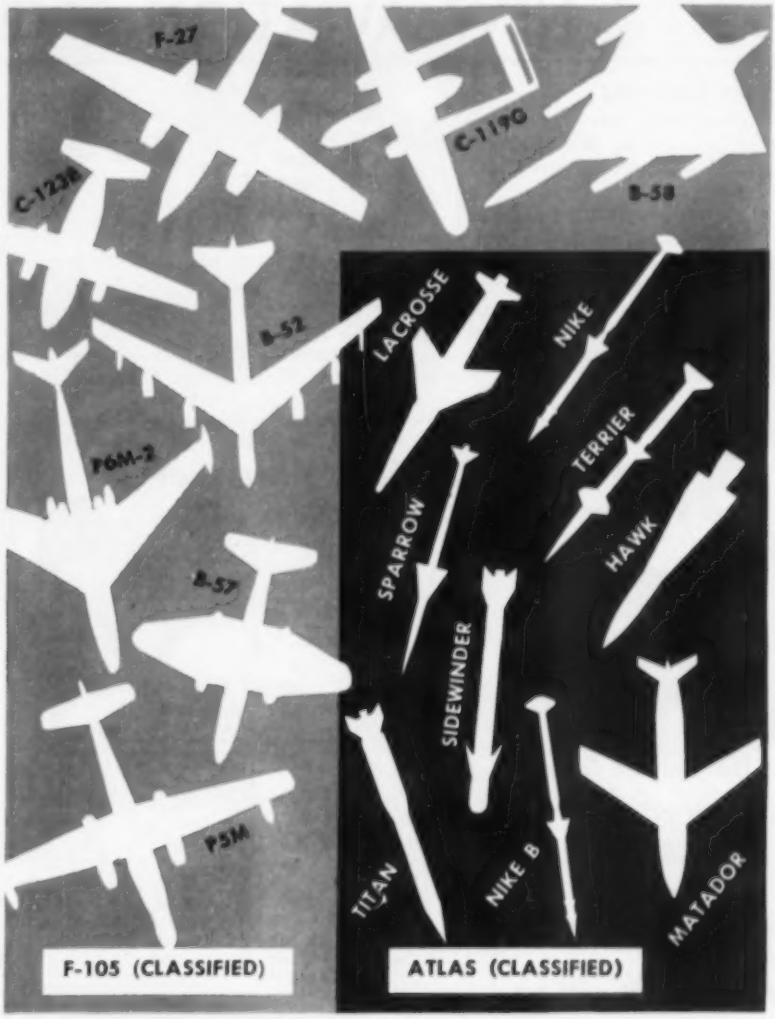
ment with high reliability. It measures 2 cu. in., requires 26 v. at 400 cycles relay excitation, has nominal input signal impedance of 2,500 ohms, although others can be obtained. Operating temperature is −55 to +100C. Manufacturer: Torwico Electronics, Inc., 1090 Morris Ave., Union, N. J.

• **Self-generating dynamic accelerometer,** Type 4-240, has a flat response within ±6% between 5 cps. and 40 kc. over an acceleration range from 0.01 to 1,000Gs. An acceleration of 5,000Gs will not damage the unit and a steady state acceleration of 200 Gs will not affect the specifications. Transverse response is 5% or less. Unit operates on the electrokinetic principle—forcing a polar liquid through a porous substance to create an electric potential across the substance—requires no mechanical linkages. Both stud and flange mounting types are available.

Consolidated Electrodynamics Corp., 300 North Sierra Madre Villa, Pasadena, Calif.

• **Three-way, two-position solenoid valve,** Type MC 1766-1, is designed to military standards. Using conventional hydraulic fluids, unit operates over a temperature range of −65 to 275F. Operating pressure is 3,000 psi. Solenoid current drain is 1.6 amps. at 29 v. d.c. at an ambient temperature of 70F. Leakage from drain port, at 3,000 psi. applied, at either of the other two ports is 5 cc./hr. maximum.

Actuation time is 0.15 sec. maximum and weight is 1.75 lb. Unit is designed for aircraft and missile use. Manufacturer is M. C. Manufacturing Co., Lake Orion, Michigan.



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Diecraft's special manufacturing techniques fly with our country's leading planes and missiles. For twenty-five years the aircraft and electronics industries have utilized the skills which have made us a leader in the manufacture of special components.

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TELEPHONE: MURDOCK 6-3390

NEW AVIATION PRODUCTS

Missile Generator

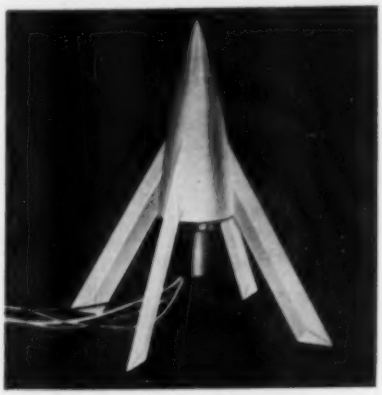
High-performance generator designed for missile power applications is a dual permanent magnet unit, 24,000-rpm., a.c. type producing 5 kva. of three-phase 400-cps., 120/208 v., unity to 0.80 lagging factor power and 3.4 kva. of six-phase 1,600 cps., 23-v. power rectified to direct current.

Using a lightweight static type voltage regulator to supply a toroidal back winding, the 400 cps. voltage is maintained constant within 0.5 v. for all steady load conditions and has rapid transient response, recovering from full-load switching in 0.1 sec.

Ruckstell Corp., 968 W. Foothill Blvd., Azusa, Calif.

Pitch/Yaw Instrument

Model 4-1 pitch-yaw indicator has free swiveling aerodynamic head to provide potentiometer output linear with pitch and yaw angles. High temperature materials are used throughout to allow operation at high Mach numbers.



Instrument is available in ranges up to 27½ deg. with an indicating accuracy of 0.1%, manufacturer reports. Overall length is 4 in. Static or total head probes are available, either singly or combined.

Edcliff Instruments, P. O. Box 307, 1711 S. Mountain Ave., Monrovia, Calif.

Subminiature Thermostat

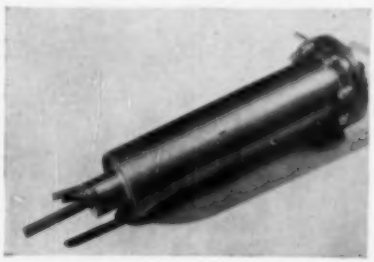
Model WP thermostat, featuring ⅞-in. dia., 0.690-in. body length and weight of 0.06 lb., incorporates bimetal actuated contact and is rated at one-half ampere for 6-28 v. a.c. or d.c. and

115-v. a.c. circuits. Temperature range of −65C to 150C is externally adjustable.

Chatham Controls Corp., 33 River Rd., Chatham, N. J.

Jet Engine Reverser Actuator

Actuator with application to jet engine reversers and other high-temperature installations has operated success-



SAC Silver Jubilee Newsreel

BY JACK PATTON

GET THAT DUST SPECK, ESAU.
NOVEMBER 1957 FRANTIC ACTIVITY AS SAC'S NEW TERMINAL NEARED COMPLETION.
WE CAN'T WEAR THESE OLD CLOTHES IN HERE!
SACSTERS FOUND NEW QUARTERS A FAR CRY FROM OLD HANGAR OFFICES.
CURB SERVICE! AND A CUSTOMERS' CONFERENCE ROOM, TOO.
CUSTOMERS OOHED AND AHHED AS THE WRAPS CAME OFF.
PEEL ME A GRAPE .... HERMAN.
LUXURIOUS FLIGHT ROOM FOR PILOTS. ANOTHER OF SAC'S FAMOUS FIRSTS.

AND NOW THE FUTURE

The eyes of Texas and of all the WINGED WORLD are on

AMERICA'S FINEST BUSINESS FLYING TERMINAL

OPEN THIS MONTH!

1932 A QUARTER CENTURY OF LEADERSHIP 1957

Southwest Airmotive Co.

LOVE FIELD DALLAS

DIVISIONS: KANSAS CITY, KANSAS / DENVER, COLORADO

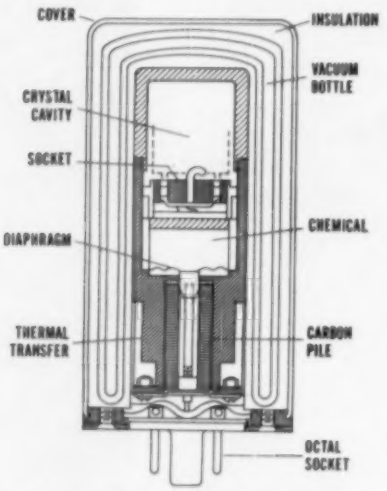
fully at 1,200F using 220 lb. of bleed air off the powerplant. Equipment avoids use of labyrinth or controlled leakage seals, using at one end an Iconel-X spring seal and a wedge seal.

Skinner Seal Co., 3001 Sutter St., Santa Ana, Calif.

Crystal Oven

Oven that utilizes the latent heat of fusion of crystalline materials will provide extremely constant crystal cavity temperatures, according to the manufacturer.

Unit has a chemical thermostat with proportional heat control in lieu of conventional bi-metallic type. Contact noise, power surge, random variations of oven temperature and cavity tem-



perature drift are said to be eliminated.

At 24C ambient, cavity temperature is 70.6C. Temperature control is within 0.5C from −20C to 50C ambient and approximately 0.005C at fixed ambient. Unit weighs 12 oz. and measures 2-in. x 4-in.

Robertshaw-Fulton Controls Co., Aeronautical Division, 401 N. Manchester, Anaheim, Calif.

Vibration Pickup

Vibration pickup designed to laboratory requirements is usable also in operational use, the manufacturer notes. Type 4-120 was initially developed for ground and in-flight monitoring of jet engines but can also be used in other high-frequency low-amplitude studies

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AIRBORNE
LORAN
COCKPIT-INSTALLED
PILOT
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OPERATED
SAVES WEIGHT, REDUCES CREW COST, ADDS TO PAYLOAD

SELECTED BY PAN AMERICAN WORLD AIRWAYS AND OTHERS AS BASIC LONG RANGE NAV AID

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COLLEGE POINT, NEW YORK

TURCOFORM PRODUCTS for Chemical Milling!

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DIVISION OF TURCO PRODUCTS, INC.
6135 South Central Ave., Los Angeles 1, Calif.

Ready NOW for the big GPU job ahead...
the Jack & Heintz G180 a-c generator!

POWER MATCHED

to advanced jet airliners!

It's already designed, thoroughly tested and ready for production, a new 160-kva generator — the highest rated machine ever designed for use in ground power units.

Power Matched! This new G180 has the same power and electrical design characteristics as the generators in today's superliners—guarantees the most precise check-outs . . . and it packs enough reserve power to preclude redesign or replacement of GPUs in event higher power systems are put into aircraft.

It is one-third the weight of comparable commercial generators . . . less costly . . . exceeds normal airline life specifications by being capable of a minimum 5000-hour life . . . will substantially lower maintenance costs.

The G180 is one of many a-c and d-c generators designed and built by Jack & Heintz for commercial and military use. For example, the J&H 750-amp d-c generator is the predominant power unit on military GPUs. More than 25,000 J&H a-c and d-c generators in support-equipment use have outstanding maintenance and service records.

Your inquiries are invited! Jack & Heintz, Inc., 17635 Broadway, Cleveland 1, O.

JACK & HEINTZ A-C GENERATORS FOR GPU SERVICE

(3-phase, 120/208 volts, 380-400 cps, 0.75 p.f.)

JAN MODEL NUMBER	31200-011	31A13-000	31A12-000	31417-000	31180-001	G180
Cont. Rating (kva)	30	40	60	90	120	120/160
Int. Rating (kva) 5 minutes 5 seconds	45 60	60 80	90 120	135 180	180 240	180/240 240
Speed (rpm)	6000	6000	6000	6000	6000	6000
Cooling Method	Self	Self	Self	6" Blast	Self	6"/11" Blast
Cooling Air (cfm)	--	--	--	360	--	360/495
Weight (lb)	78.5	84	120	180	265	260
Overhung Moment (in-lb)	330	389	840	1215	2958	3000
Length (in.)	14.7	15.0	17.9	20.0	22.0	22.0
Diameter (in.)	10.25	10.25	10.75	11.0	11.0	11.0
Mounting Flange	AND10266 Type XVI-A	AND10266 Type XVI-A	AND10266 Type XVI-B	AND10267 Type XVII-C	AND10267 Type XVII-C	AND10267 Type XVII-C

JACK & HEINTZ, Inc.
AIRCRAFT SYSTEMS AND EQUIPMENT

under temperature extremes from −65F to 500F.

Frequency range is 40-2,000 cps. with linearity of ±4% of reading, for constant frequency, over the entire range. It is insensitive to transverse vibration, according to the maker, and will produce a signal directly proportional to the velocity as low as the recording equipment will measure. Maximum damage-free acceleration is 50G.

Unit measures 1¾ x 2¾ in. and weighs under five ounces.

Consolidated Electrodynamics Corp., 300 N. Sierra Madre Villa, Pasadena, Calif.

Metallic Snubbers

Snubbers to damp out high pressure surges and pump ripples, allowing smooth pressure increase to protect aircraft and missile pressure-operated instruments and controls, are of all-stainless steel construction.

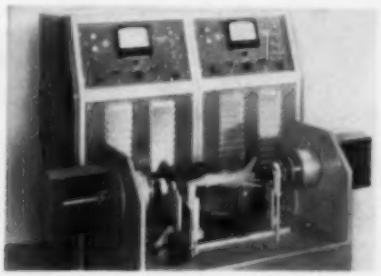
Units are designed for systems with operating pressures up to 4,000 psi., proof pressure of 6,000 psi. and burst pressure of 10,000 psi. They operate at fluid and ambient temperatures from −65F to 400F, with special models capable of working at 1,000F. Equipment comes in varying sizes down to ⅛-in. x 1⅛-in. Typical weight is reported as 0.037 lb. for ¼-inch line size.

A. U. Stone & Co., 23 W. 60th St., New York 23, N. Y.

Simulation Table

Two degree of freedom simulation table is used for angularly displacing gyros and accelerometers, in pitch or roll, either statically or dynamically. The servo-controlled table is used in conjunction with an analog computer to provide flight test conditions of an aircraft or missile stabilization system.

Equipment may also be used as an



oscillating table to determine threshold characteristics of high performance gyros and accelerometers. Table will follow signals from an analog computer, a low frequency function generator, a tape recorder or a digital-to-analog converter.

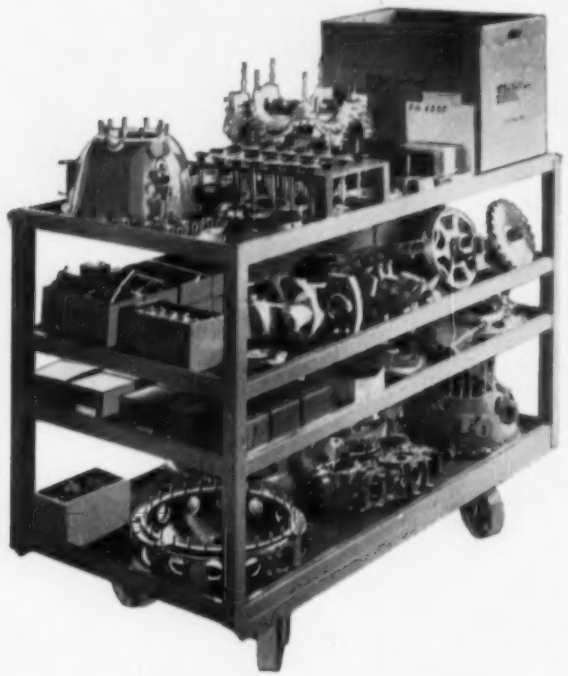
Micro Gee Products, Inc., Box 1005, 6319 Clayton Ave., Culver City, Calif.

Stick Force Dynamometer

Model 330 stick force dynamometer contains a force balance to measure maneuver force pilots apply to controls and does not need stick modification.

Grip-shaped unit is completely interchangeable with the B8A grip assembly, the manufacturer reports, and is designed for ±150-lb. fore and aft loads and ±75-lb. side loads; unit also provides required overload capacity.

Task Corp., 1009 E. Vermont Ave., Anaheim, Calif.



THIS IS ENGINE E7592

Airwork never scrambles engine parts on a mass production basis. When this engine was torn down for overhaul—the parts went on this cart. The cart kept all re-usable parts together as they went through Cleaning, Inspection and Rework. Now, new parts have been issued. The cart is ready to start through Assembly.

These carts preserve your investment. If a vital part has a potential 10,000 hour life—and you have used it for 1,000 hours—that's the one that goes back on your engine. Under the usual shop system, you could end up with a 9,000 hour part . . . and a big bill next time.

Mating parts that have "worn in" are re-mated. And . . . you get individual treatment of the operating problem shown by the internal condition of your engine at overhaul.

Only Airwork offers this individualized overhaul method . . . the best you can get anywhere.

Airwork CORPORATION
Millville, New Jersey

BRANCHES IN:
WASHINGTON
NEWARK • MIAMI • ATLANTA
CLEVELAND

BELL salesmen, using 47Js like this one shown over Chicago, demonstrate two weeks out of six, devote rest of time talking to prospects.

Bell Plans to Widen Helicopter Market

By Craig Lewis

Ft. Worth—Bell Helicopter Corp. is experimenting with new sales techniques in an effort to find the best method of merchandising helicopters. Sales programs have been extensively overhauled in the past six months in Bell's search for the ideal commercial helicopter sales technique.

This aggressive approach to selling helicopters is designed to accelerate the growth of commercial sales and lay the ground work for more sophisticated programs at the same time. And increased commercial business will also improve Bell's ability to roll with the shocks of on-again-off-again peacetime military budgets.

1957 Business

Bell sold more commercial helicopters in the first nine months of this year than in all of 1956, and total commercial business for 1957 is forecast at about $10 million. This includes income from spares business and the Bell training school. The company doesn't release figures on unit sales, but this year's business probably will cover unit sales on the order of 160 helicopters.

Sales in 1957 are about 30% higher than they were in 1956, and this increase fits in with the general growth trend over the past few years. Another 30% increase in commercial sales is predicted for next year. Bell has an eventual goal of $25 million annual commercial business.

Bell believes that the growth of commercial helicopter sales depends primarily on greater acceptance of the machine as a business tool. "It's a big educational job," Bell President Harvey Gaylord told AVIATION WEEK, and he said that more aggressive selling will hasten this educational process.

This view is echoed by Bell's new commercial domestic sales manager, Fred Roscoe. He points out that greater use of helicopters will promote more heliports and more service facilities. As these facilities increase, the cost and convenience of operating and maintaining the helicopter will decrease.

The Korean war was the factor that really brought the helicopter to prominence, Roscoe said, and its use in offshore oil development has made a similar kind of contribution. The operations of New York Airways, Los Angeles Airways and Chicago Helicopter Airways also help by introducing the helicopter to businessmen through the ordinary channels of air transportation.

Roscoe also points out that as the helicopter becomes more popular for business use, smart businessmen will find new uses for it, thus creating new markets.

With this cycle of increased acceptance and use, commercial sales ought to gather momentum at some point, and Gaylord said "we will be disappointed" if sales don't begin to snowball after another three years or so. He said that Bell expects sales growth to exceed the present rate of 20-30% a year when this momentum begins to pick up.

Higher production rates that accompany higher sales volume could make another contribution to better sales. Gaylord estimates that if Bell could eventually produce 4,000 to 5,000 helicopters a year, the company could cut prices 40 to 50%.

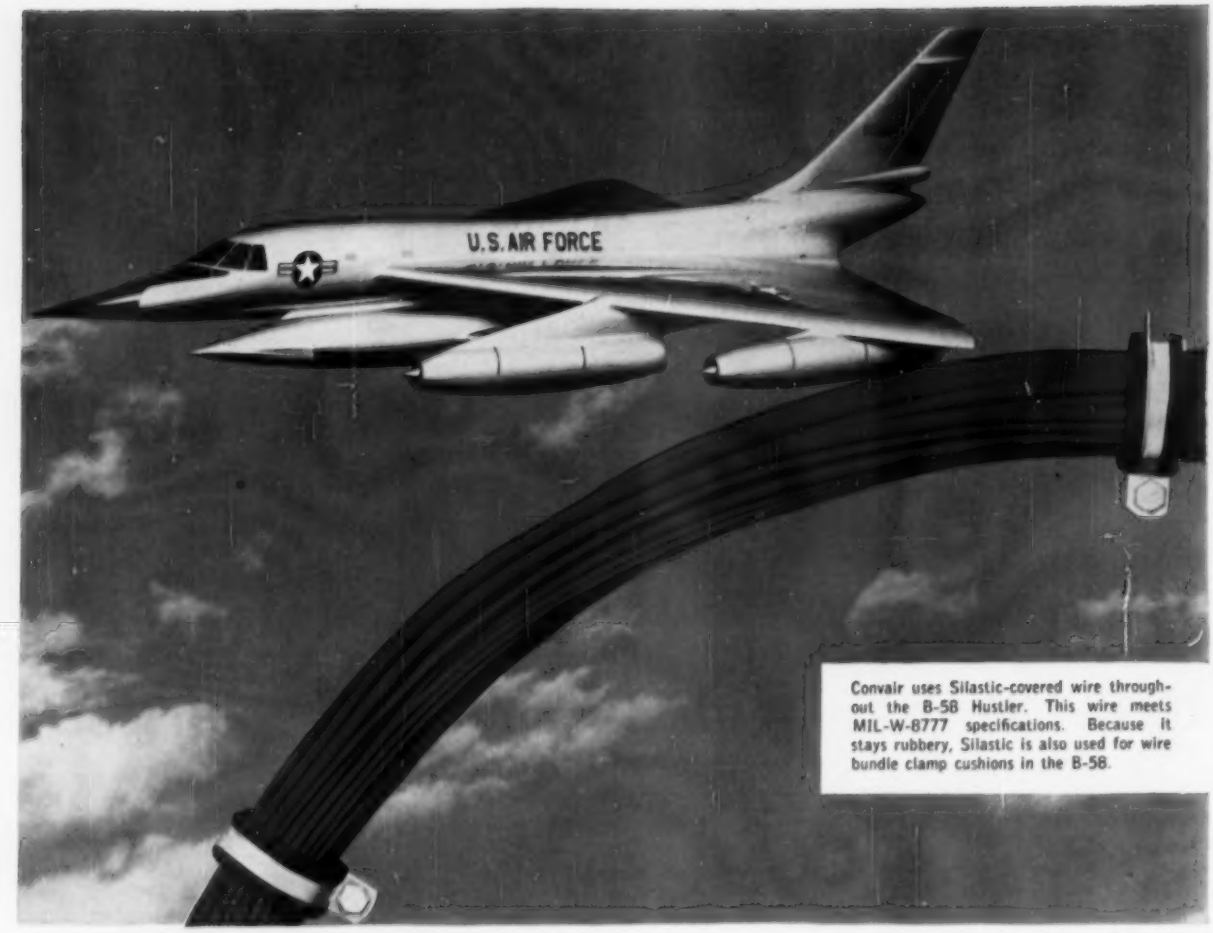
Stability Prospect

For a government contractor subject to the vagaries of fluctuating military budgets, more commercial business represents a welcome stability. Bell figures a 50-50 split between military and commercial business would be ideal.

This kind of a split, which Bell hopes to approach eventually, would permit the company to keep its facilities running on an austere basis even in the leanest military budget years.

To promote a bigger share of commercial business, Bell is experimenting with sales techniques to determine the best way to sell helicopters. In the present phase, the company is trying out techniques used to sell fixed-wing aircraft, and Roscoe left his job as domestic sales manager for Cessna Aircraft Corp. last summer to run the new program for Bell.

Where Bell formerly had three salesmen covering the country, there will now be eight salesmen and a division manager selling in the field, all with



Convair uses Silastic-covered wire throughout the B-58 Hustler. This wire meets MIL-W-8777 specifications. Because it stays rubbery, Silastic is also used for wire bundle clamp cushions in the B-58.

SILASTIC
SILICONE RUBBER

insulation stays rubbery at 500 F

For resistance to fuels, oils and solvents, specify Silastic LS

Even continuous exposure to temperatures ranging from —130 to 500 F won't affect the resiliency or high dielectric strength of Silastic*, the Dow Corning silicone rubber. Silastic repels moisture, resists weathering, ozone, arcing and corona. That's why Silastic assures peak insulation efficiency for electrical wire and cable. Offered by leading wire manufacturers.

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Typical Properties of Silastic for Wire and Cables

• Temperature range, °F	—130 to 500
• Tensile strength, psi	600 to 1500
• Elongation, %	150 to 450
• Insulation resistance, megohms/1000 ft	1000 to 3000
• Dielectric strength, volts/mil	300 to 500
• Dielectric constant, 10^2 cycles per second, nominal	3.2

If you consider ALL the properties of a Silicone rubber, you'll specify SILASTIC

first in silicones

Dow Corning CORPORATION
MIDLAND, MICHIGAN

MANUFACTURERS demonstrate new bolt wrenching process. Gear was hauled in helicopter, mounted on landing gear for demonstration.

guidance from Bell's main plant here. The sales territory east of the Rockies has been split up into four regions, and salesmen now operate out of New York, Buffalo, Cleveland and Ft. Worth. A fifth region will be added when a salesman now in training begins operating out of Chicago.

Western Plan

The western states are getting a different approach. Bell has set up a Western Division with a division manager in Los Angeles. The division is split into three regions, and the salesmen in these regions report to Los Angeles.

The Western Division operates as a sort of sales and service package deal. Bell has a parts depot in Los Angeles stocked with the most commonly used spares, providing rapid parts delivery for customers in the western states. If this approach works out well, it may be extended to cover the country.

Helicopter operators in the eastern U. S. now have a Bell service representative to help them with their problems, and a service rep will be provided for the western states. Operators in the central states can call on the Ft. Worth plant for help.

Salesmen use the model 47J for most demonstrations. Four of these machines are rotated through the regions. Salesmen usually fly the demonstrators two weeks out of six, using the other four weeks to set up demonstrations and follow-up calls. One 47G-2 demonstrator is based on the West Coast, and another 47G-2 will be added in April.

Currently, Bell is producing the utilitarian three-place Model 47G-2 priced at $39,500 and the plusher four-place 47J costing $68,500. Some of the older Model 47G and 47H ma-

For fast single-point FUELING AND DEFUELING

Weight saving and simplification of fueling operations are achieved through use of FRI GA-2 Adapter. This Adapter eliminates need for additional fueling points and associated plumbing by providing fast, efficient fueling and defueling through the aerial refueling probe on military aircraft. The GA-2 Adapter fits on existing MA-2 fueling nozzles and gives positive check on the operational status of aerial refueling receiver system during ground fueling thus eliminating need of separate check equipment.

Designed and produced by Flight Refueling, Inc., these components are flight-proved for production installations. FRI components simplify assembly and increase system flexibility.

Also Available:

FRI CHECK VALVES for aircraft systems are lightweight (less than 5 oz.), reliable, and extremely versatile. The CV-1 can be installed either by using standard beaded pipe connectors or it may be incorporated into any long tube merely by expanding a small section. These flight-proved valves are positive sealing and feature low "cracking" pressure and low pressure drop. Design makes it practical for use with most fluids and gases. Operating temperature range is —65°F. to 160°F.

F-R PIPE CONNECTORS — These versatile, flexible pipe connectors with a tolerance for minor misalignment of pipes and tubing save assembly time and speed production. They are light weight and pressure tight, and answer the problem of connecting beaded pipes in which high pressures must be accommodated. They have satisfactorily met flexure test of over 5 degrees and have been tested over 15,000,000 cycles of continuous vibration without leakage. Sizes 1" to 4" off-the-shelf, larger sizes to order.

For specialized fuel system components to your specifications, contact Flight Refueling, Inc. Many production items immediately available.

Flight Refueling, Inc.

FRIENDSHIP INTERNATIONAL AIRPORT Baltimore 3, Maryland

For High Strength-Weight Ratios up to 1000 F

Specify New Armco PH 15-7 Mo Stainless

Guaranteed F_{tu} of 225,000 psi, combination of exceptional properties, and producibility, create new possibilities in design of aircraft and missiles.

These graphs illustrate only two of the many characteristics of Armco's new PH 15-7 Mo Stainless Steel that can help solve problems in the design and production of high-mach missiles and planes. Combining excellent mechanical properties up to 1000 F, corrosion resistance and good fabricating characteristics with producibility in all forms, PH 15-7 Mo meets all aircraft manufacturing requirements.

Higher Properties at Temperatures to 1000 F

On a strength-weight basis in the critical range of 600 to 1000 F, Armco PH 15-7 Mo is superior to other aircraft materials. Its tensile and compressive properties and creep strength permit the design of airframe and power unit elements that are more resistant to the combined effect of heat and stress.

Designs can be based on these ultra-high guaranteed minimum properties:

Easy Fabrication Adds to Economy

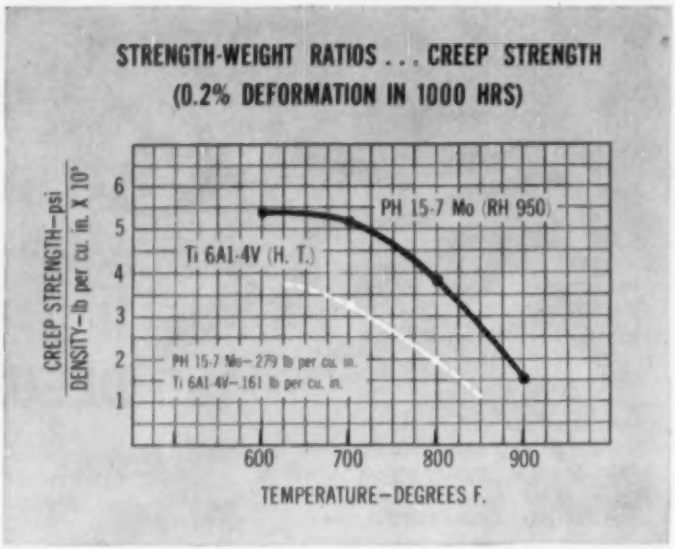
Much less expensive than titanium alloys, Armco PH 15-7 Mo is also the most easily fabricated of all the high strength aircraft materials. This characteristic not only simplifies design but speeds production and cuts unit costs. Fabrication methods and low temperature heat treatments are identical to those for widely used Armco 17-7 PH.

Commercially Available in All Forms

The new grade is available now in the form of sheet, strip, thin gage strip (foil), plate, bar, wire, and forging billets. All are produced in commercial quantities.

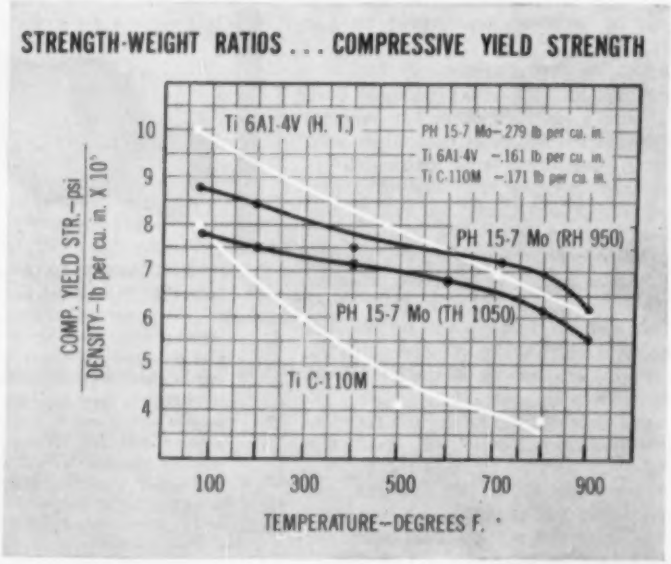
Armco PH 15-7 Mo is the newest addition to Armco's family of workable precipitation-hardening stainless steels. Others are Armco 17-7 PH and 17-4 PH.

Write us at the address below for full information on properties, fabrication and available sizes.



Guaranteed Tensile Properties
Armco PH 15-7 Mo Sheet and Strip

	Condition		
	RH 950	TH 1050	A
Ultimate strength, psi	225,000 min.	190,000 min.	150,000 max.
0.2% Yield strength, psi	200,000 min.	170,000 min.	65,000 max.
Elongation, % in 2 in.	4% min.	5% min.	25% min.



ARMCO STEEL CORPORATION

2417 CURTIS STREET, MIDDLETOWN, OHIO

SHEFFIELD DIVISION • ARMCO DRAINAGE & METAL PRODUCTS, INC. • THE ARMCO INTERNATIONAL CORPORATION

chines are still in inventory and for sale, although they are no longer in production.

Sales of the current production models are just about evenly split between the 47G-2 and the 47J. While there is little to choose between the two in performance, added capacity and better looks seem to promote as many sales of the 47J as of the much cheaper 47G-2.

Helicopter a Commodity

Roscoe feels the helicopter is a commodity competing with any other $60,000 commodity, not just a helicopter competing with other helicopters. To back up this approach, he plans to use modern marketing techniques to pinpoint the likeliest markets, then develop new sales tools through experimentation to develop these markets.

Best prospect for future development right now is the executive transport field, according to Roscoe. He feels that interest in using the helicopter for travel between plants and in terminal areas is increasing. Bell will push sales in this area, and Roscoe says that it will be a key to bigger growth in commercial sales.

Up to the time the sales program was reorganized this year, Bell sold most of its helicopters to charter companies and other operators who in turn sold their services to industry. As interest has increased, more businesses have decided to buy machines instead of leasing them. So now Bell is concentrating more and more on direct sales to industry. Company feels that the historic growth in sales to charter operators will continue its steady upward curve and that new sales direct to industry will provide the extra growth Bell wants to expand its commercial sales base.

New Customers

Nearly 40% of sales this year are going to new customers. Bell still makes the majority of its sales to old customers updating or expanding their fleets, but little or none of this is replacement business. Old helicopters seem to get rebuilt and kept in service, and prices for used machines are holding up very well.

Charter operators form the largest single group buying helicopters this year with 37% of total sales. Foreign governments took another 20% for their military forces, and 13% were sold for executive transportation. Next biggest markets were air taxi, police use and oil industry applications. Other machines were sold for ranch use, crop dusting and spraying, exploration, forestry, powerline patrol and fishery work.

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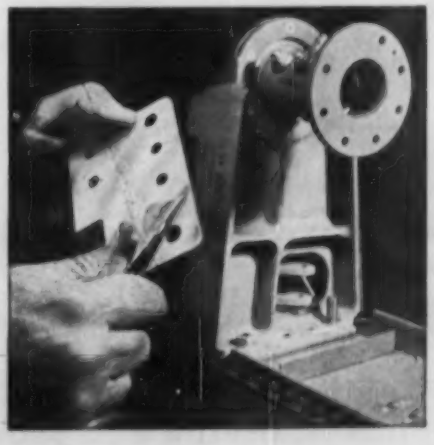

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tirely accurate picture of the proportional use made of the helicopter, since it is impossible to tell what the large segment of charter operators are using their machines for. But they do give an indication of Bell markets for direct sales.

The best market for Bell's sales efforts right now is probably the group of companies which operate fixed-wing aircraft. They are already airminded, and they have the flight organization and maintenance setup to handle a helicopter easily. Roscoe said this group will be a primary sales target.

Tied to Jets

Roscoe thinks that as some companies move on to turbine powered fixed wing aircraft, they will have an increased need for helicopters to help justify their investment in jet aircraft. In order to take full advantage of the increased speed of the jets, operators will have to cut ground time between the bigger, more remote airfields needed for the jets and the plant or downtown office.

This year, about 30% of Bell's commercial sales were made to overseas customers, compared with 35% last year. This is in line with the declining trend from a point six years ago when 70% of sales were for export. Bell's overseas dealers must compete with companies in Japan and Italy licensed to build and sell Bell helicopters, but the company figures it only loses about 5% of its overseas customers to them. Most licensee sales are made in soft currency areas where Bell couldn't afford to do business anyway.

Bell's president Gaylord feels that a more aggressive and more sophisticated sales effort can greatly expand commercial sales with the helicopters now available. He does not believe that any technical breakthroughs or radically improved machines are needed before the helicopter can be widely promoted as an accepted mode of business transportation.

More Sales Effort

Gaylord admits that technical breakthroughs are always desirable, but he says that improvement can just as easily come from new fuels and materials applied to present types. He believes that greater sales effort, not a better machine, is needed to increase sales.

Turbine power represents a new era in helicopter powerplants, but Gaylord points out that there is no family of small turbine engines available which is suitable for adaptation to a machine of the 47J's size.

He thinks the turbine-powered H-40 that Bell is currently developing for the Army may well have commercial applications similar to those of the 47J some time in the future.

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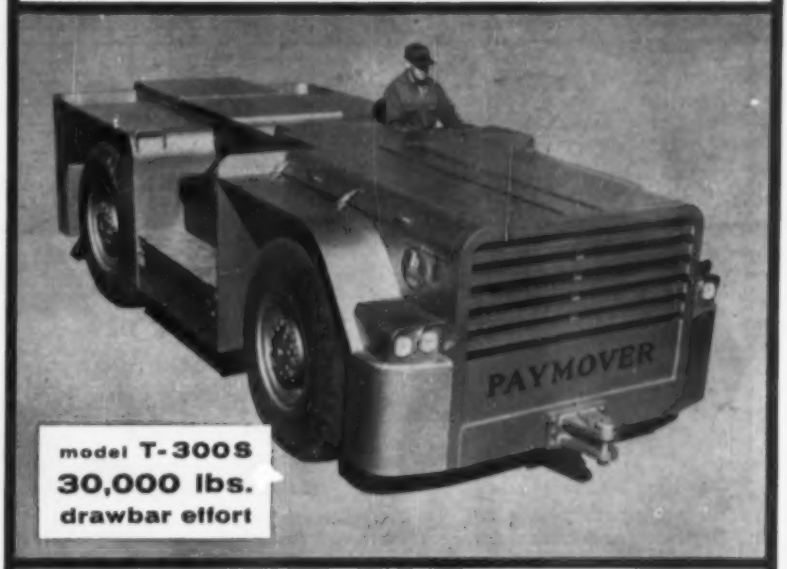

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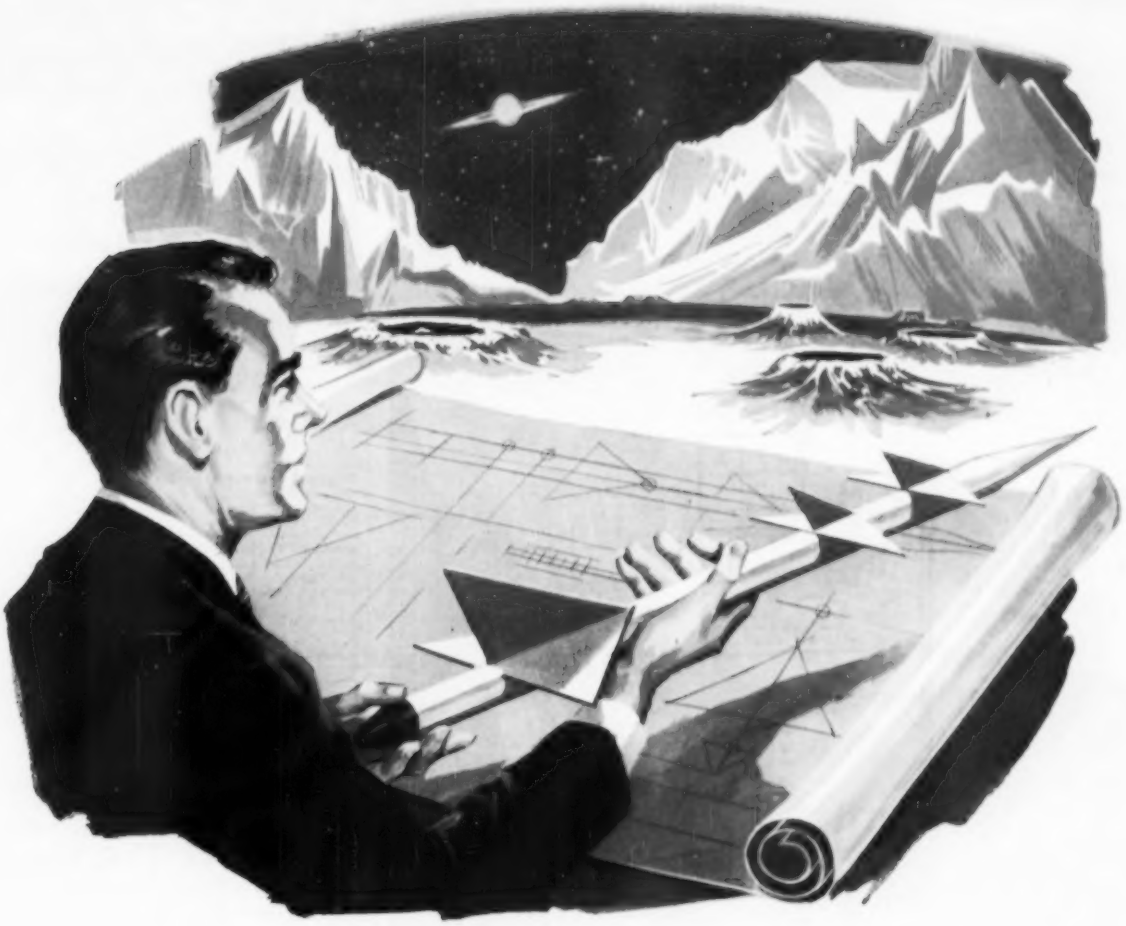

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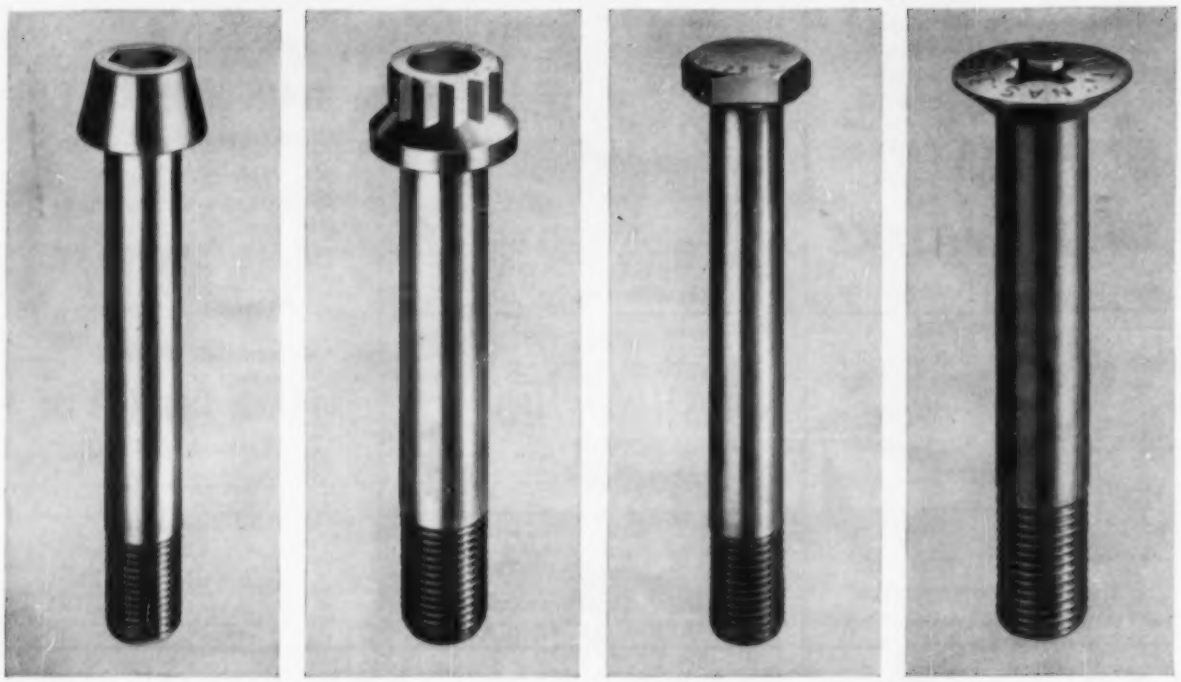

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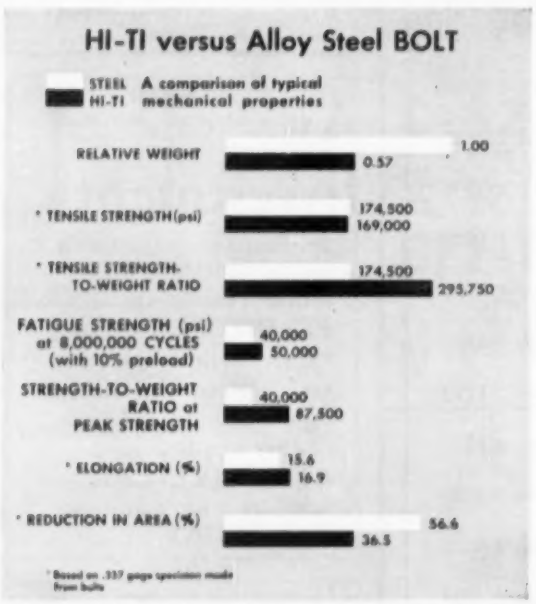

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AMERICAN CABLE & CHAIN, AUTOMOTIVE & AIRCRAFT DIVISION 77
Agency—Reincke, Meyer & Finn
ARMA DIVISION, AMERICAN BOSCH ARMA CORP. 100
Agency—Davis, Kitchen & McCormick, Inc.
ARNOLD MAGNETICS CORP. 91
Agency—Balsam Adv.
ARMCO STEEL CORPORATION 124
Agency—N. W. Ayer & Son, Inc.
AVCO MANUFACTURING CORP., CROSLEY DIVISION 24
Agency—Benton & Bowles, Inc.

BRIDGEPORT BRASS COMPANY (ALUMINUM DIVISION) 90
Agency—Hazard Adv. Co., Inc.

CANADAIR, LTD. 38
Agency—Walsh Advertising Company, Ltd.
CENTURY ELECTRONICS & INSTRUMENTS, INC. 57
Agency—Gibbons Advertising
CHANCE VOUGHT AIRCRAFT, INC. 106-107
Agency—Tracy-Locke Adv. Co., Inc.
CONSOLIDATED ELECTRODYNAMICS CORPORATION 82
Agency—Hixson & Jorgensen, Inc.
CONTINENTAL MOTORS CORPORATION 89
Agency—The Hoefkins Agency
CONVAIR—DIVISION OF GENERAL DYNAMICS CORPORATION ..... 2nd Cover
Agency—Buchanan & Co., Inc.

DIECRAFT INC. 115
Agency—Ogden & Stronce Co.
DOW CHEMICAL COMPANY 4
Agency—McManus, John & Adams, Inc.
DOW CORNING CORPORATION 122
Agency—Church & Guisewhite, Inc.

EDO CORPORATION 117
Agency—Davis, Parsons & Strohmeier, Inc.
ELASTIC STOP NUT CORPORATION ..... 4th Cover
Agency—G. M. Basford Company
ELECTRICAL ENGINEERING & MFG. CORPORATION 35
Agency—West Marquis, Inc.
ELECTRO SNAP SWITCH & MFG. COMPANY 58
Agency—Stoetzel & Associates, Inc.
ESSO EXPORT CORPORATION, AVIA PRODUCTS 56
Agency—McCann Erickson, Inc.

FLIGHT REFUELING, INC. 123
Agency—Davis, Parsons & Strohmeier, Inc.
FORD MOTOR COMPANY 18
Agency—Kenyon & Eckhardt, Inc.

GABB SPECIAL PRODUCTS 133
Agency—Charles Palm & Company, Inc.
GENERAL ELECTRIC COMPANY 44, 53, 84, 84, 85
Agency—G. M. Basford Company
GOODRICH COMPANY, THE B. F. 20
Agency—Batten, Barton, Durstine & Osborn, Inc.
GRUMMAN AIRCRAFT ENGINEERING CORPORATION 10-11
Agency—Fuller & Smith & Ross, Inc.

HALOID COMPANY, INC. 72
Agency—Hutchins Advertising Co.
HAYES AIRCRAFT CORPORATION 7
Agency—Silver & Deuce Company, Inc.
HOUDAILLE IND., INC., BUFFALO HYDRAULICS DIVISION 86
Agency—Comstock & Company
HOUGH CO., FRANK G. 127
Agency—Ervin R. Abramson Advtg.

INTERNATIONAL BUSINESS MACHINES 47
Agency—Benton & Bowles Inc.

JACK HEINTZ, INC. 118-119
Agency—Fuller & Smith & Ross, Inc.
JOHNS MANSVILLE 126
Agency—J. Walter Thompson Co.

KAISER ALUMINUM & CHEMICAL CORPORATION 74-75
Agency—Young & Rubicam, Inc.
KELSEY HAYES COMPANY 101
Agency—Zimmer, Keller & Calvert, Inc.
KIDDE & COMPANY, INC., WALTER 22
Agency—Cunningham & Walsh, Inc.

LAMINATED SHIM COMPANY 125
Agency—Wilson, Haight, Welch & Grover, Inc.
LINEAR, INC. 14
Agency—The Aitkin-Kynett Company
LINK AVIATION, INC. 103
Agency—Gaynor & Ducas, Inc.
LOCKHEED AIRCRAFT CORPORATION 48-49
Agency—Foote, Cone, Belding Adv.

MALORY SHARON TITANIUM CORPORATION 42
Agency—The Griswold-Eshleman Company
MARTIN COMPANY 108-109
Agency—Vansant, Duplaix & Company, Inc.
MERGENTHALER LINOTYPE CO. 9
Agency—Hazard Advtg. Co.
MICHIGAN CHROME & CHEMICAL CO. 64
Agency—Karl G. Behr
MINNEAPOLIS-HONEYWELL REGULATOR COMPANY 58-59
Agency—Foote, Cone & Belding

MONSANTO CHEMICAL COMPANY 88-89
Agency—Gardner Advertising Company
MOTOROLA, INC.—COMMUNICATIONS EQUIPMENT 110
Agency—Kolb & Abraham Inc.
MUELLER BRASS COMPANY 111
Agency—Price, Tanner & Willox, Inc.

NARMCO RESINS & COATINGS COMPANY 8
Agency—Riley Nelson Company

OSTER MFG. COMPANY, JOHN—AVIONIC DIVISION 112
Agency—Burtch Browne Adv.

PACIFIC AUTOMATION PRODUCTS, INC. 70-71
Agency—Anderson McConnell Advtg. Agency
PHILCO DIV. TECHREP DIV. 135
Agency—Maxwell Associates, Inc.
PHILCO CORPORATION—G & I DIVISION 76
Agency—Maxwell Associates, Inc.
PHILLIPS PETROLEUM COMPANY 5
Agency—Lambert & Feasley, Inc.

REACTION MOTORS, INC. 15
Agency—Aitkin-Kynett Co.
RED BANK DIVISION—BENDIX AVIATION CORPORATION 96
Agency—MacManus, John & Adams, Inc.
REPUBLIC AVIATION CORPORATION 68
Agency—DeGarmo, Inc.
ROCHESTER MFG. CO. 102
Agency—Hutchins Advtg. Co.
ROLLE MANUFACTURING COMPANY 94
Agency—The Harry P. Bridge Company
RYERSON & SON, INC., JOSEPH T. 101
Agency—Buchen Co.

SCIAKY BROTHERS, INC. 66
Agency—Russell T. Gray, Inc.
SERVICE STEEL DIVISION—VAN PELT CORPORATION 95
Agency—Claude E. Whipple Adv.
SIMMONDS AEROCESSORIES, INC. 16
Agency—Burke Dowling Adams, Inc.
SINCLAIR REFINING COMPANY 65
Agency—Morse, Hunen, Inc.
SOUTHWEST AIRMOTIVE CO. 116
Agency—Don L. Baxter Co.
SPERRY GYROSCOPE COMPANY—DIV. OF SPERRY RAND CORPORATION ..... 3rd Cover
Agency—Reach, Yates & Mattoon, Inc.
STANDARD PRESSED STEEL COMPANY 134
Agency—Gray & Rogers Adv.
STROMBERG-CARLSON, DIV. OF GENERAL DYNAMICS CORPORATION 114
Agency—Charles L. Rumrill & Company, Inc.
SUNDSTRAND MACHINE & TOOL COMPANY 12-13
Agency—Howard H. Monk & Associates

THERMO ELECTRIO COMPANY, INC. 113
Agency—Fred Lange Associates, Inc.
TORRINGTON COMPANY, THE 92
Agency—Hazard Adv. Company
TOWNSEND COMPANY 73
Agency—Bond & Starr, Inc.
TRANS SONIC INC. 6
Agency—Technical Marketing Associates, Inc.
TURCO PRODUCTS, INC. 117
Agency—Van Der Boom, Hunt, McNaughton, Inc.

VICKERS, INC., DIVISION OF SPERRY RAND CORPORATION 3
Agency—Witte & Burden Adv.

WAUGH ENGINEERING CO. 101
Agency—Frank A. Wood
WESTERN GEAR CORPORATION 60
Agency—Burke Dowling Adams, Inc.
WESTINGHOUSE ELECTRIC CORPORATION 62-63
Agency—Fuller & Smith & Ross, Inc.

CLASSIFIED ADVERTISING

F. J. Eberle, Business Mgr.

EMPLOYMENT OPPORTUNITIES 128-130
EDUCATIONAL Books 132
EQUIPMENT (Used or Surplus New) For Sale 131-133

ADVERTISERS INDEX

Air Carrier Engine Service Inc. 132
Cornelius Co. 128
Engine Works 133
Flying Tiger Line, Inc. 132, 133
General Electric Co. 128
Goodyear Aircraft Corp. 129
Goodyear Atomic Corp. 128
Los Angeles Air Service 133
Minnesota Airmotive Inc. 132
National Metals Co. 132
Norton Air Force Base 131
Navco 132
Rommert-Werner Inc. 132
Rohr Aircraft Corp. 130
Skymotive Inc. 133
Steward-Davis Inc. 132, 133
Trade-Ayer Co. 132

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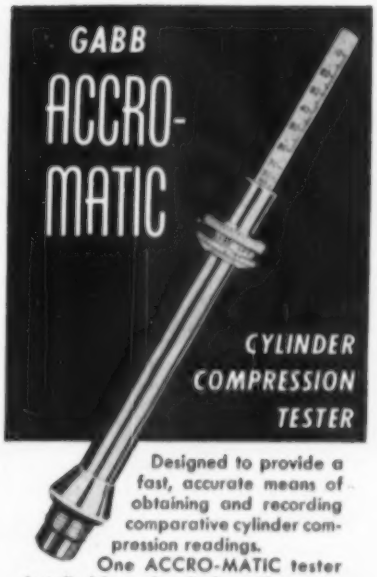

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LETTERS

Proud Subscriber

I have noted the instructions from Mr. Cutler, of the White House staff, that business should boycott your magazine because of your article regarding our radar observations of Russian missile tests from Turkey (AW Oct. 21, p. 26). Since I wish to be a good American, and in line with Mr. Cutler's instructions, I am, therefore, advising you to renew my expiring subscription for an additional three years. Would you please advise your subscription department of this boycott step and bill me.

I am sending a copy of this letter to the White House for Mr. Cutler's information. I would also like to mention that, in the event that you are tried for treason by Mr. Cutler, you can depend on my support in your hour of travail.

Mr. Eisenhower is very fond of making statements about his "faith in America." Apparently, however, Mr. Eisenhower does not quite have faith enough in America to believe that the American people are now grown up enough to evaluate facts, figures and information. Furthermore, the White House staff, including Mr. Cutler, seems to have a deathly fear of the truth. In fact, Mr. Cutler seems to go all to pieces at the very thought of it.

To sum this all up, I think this nation owes you and your publication a great measure of thanks for the article you have published. I am proud to be a subscriber to your magazine. I am sure that I, as well as most all Americans, am quite capable of thinking for myself and God help us if we ever have to delegate this process to people like Mr. Cutler.

Creighton Merrell
Merrell Aviation
Boeing Field
Seattle, Wash.

Statement Rephrased

Please pardon the delay, necessitated by Asian flu, in congratulating you on your editorial in the Oct. 28 issue of Aviation Week, "Intelligence Without Leadership." I think you have very effectively brought out the fact that neither political party nor military divisions have a monopoly on errors of judgment. You have rather subtly indicated that both the Democrats and Republicans, and the Army and Navy, were deaf to available intelligence in 1936, 1941, 1954 and 1957. You also indicate that the aviation industry is composed of many factors not only involving engineering and science, but education, political science and everyday living.

I hope that you may continue to point out that until every United States citizen accepts his individual responsibility to work for the best education, the best political machinery and the best scientific research, it is possible that we have all slept too soundly.

My only suggestion would be that you should have rephrased your statement, "History is full of examples of disasters that overtake nations whose top leadership refuses to act on the basis of good military intelligence," to read, "History is full of examples of disasters that overtake nations whose top leadership refuses to act on the basis of good intelligence."

Let us hope that all America uses its native-born intelligence and its ability to evaluate properly what additional steps must be taken to improve basic education, political science, engineering and general science.

Richard L. Auten
Stratford, Conn.

Aviation Week welcomes the opinion of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 330 W. 42 St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.

Treason Question

Keep up the good work. Your editorials of super-secrecy for the American public are right to the point. If there is any question of "treason," it comes closer to fitting the other foot for not acting on the knowledge in hand for two years and deceiving the people.

Philip Y. Pohlman
La Canada, Calif.

British Intent

In his article on electronic countermeasures, Philip J. Klass tells how the British, during World War II, shifted the intersection of radio navigational beams used by the German bombers ". . . with the result that many bombs fell in the channel instead of in London."

Mr. Klass does not say what happened when the intended targets of the Germans were cities on the west coast of England. Then, according to the American scientist from whom I obtained my information, the beam intersection was placed—by the British—over neutral Eire.

Churchill intimates in his history of the war that the German bombings of Eire, including the city of Dublin, were the "inadvertent" result of British electronic countermeasures, but the explanation given to me attributes these incidents to British intent.

Although it would have been possible to deceive the Germans into dropping their bombs in the Irish Sea, it was preferable, from the British point of view, to provoke Eire into belligerency against Germany or, if this stratagem were not successful, at least to punish the Irish for their neutrality.

Eugene T. Doyle
South Farmingdale, N.Y.

Requests Apology

I have just read your editorial in the issue of Oct. 14. In it I found such inflammatory statements as: ". . . contemptuous attitude of former Defense Secretary Charles E. Wilson toward science and basic research . . .," ". . . President Eisenhower's widely quoted dismissal of scientists as 'just another pressure group . . .'" "Incredible financial bungling in the Pentagon. . . ." These statements were to show why we are behind Russia in missile development.

Statements such as these are of the common soap box variety and mean absolutely nothing. The reason we are behind the Soviets is mainly that we did nothing in the years 1946-47-48-49-50 and 51. Probably the best person for you to blame will be yourself for not being successful in waking the American people to the importance of this problem. Hindsight is always easier than foresight, Mr. Editor, and if you had done a tenth of what the officials you named have done for their country you might be in a better position to say the things you did.

I think a publicized apology on your part is in order.

Irving C. Sheldon
North Kingstown, R. I.

Wrong Suit

In my letter of Oct. 23 I advised you of the decision by the Federal Court in the suit between Electrofilm Corp. and EverLube Corp. (AW Nov. 4, p. 104, "Decision Handed Down in Electrofilm Suit").

As you know, I am executive vice president of EverLube Corp. and president of Therm-O-Lab Corp. Unfortunately my personal association with these two firms has no doubt created some confusion in the minds of your editorial department. Actually, the law suit filed by Electrofilm Corp. in the Superior Court of California against Therm-O-Lab Corp. is still pending. The Federal Court suit is between Electrofilm Corp. and EverLube Corp. In this Federal suit the Electrofilm dry film lubricant patent was held invalid by Judge Leon Yankwich.

I sincerely regret this situation has occurred, and am rushing this letter to you in an effort to clear up a misunderstanding.

A. R. Booker
Executive Vice President
EverLube Corporation of America
North Hollywood, Calif.

Action Equals Reaction

Hey, diddle, diddle Old Ike's in the middle
as the Reds ran away with the moon—
For Ike didn't know that rockets could go
Quite so far, or so fast, or so soon.
The British, confounded, perplexed and
astounded, sent a PM scurrying here.
While the French disillusion took the form
of confusion with its typical Marianne
leer.
"Voila! La Sput-nique, Zey are all up ze
creek!" Said the Frenchman to all who
would hear.
The British, however, quickly talked of the
weather and returned to the pub for a
beer.
Then the Yankees on our side touched off
Rocket Farside though just where it
went is not clear.

John Keats
Philadelphia, Pa.

for Delta's new Convair 880's...

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SPENCER KELLOGG II, Assistant Chief Engineer of Aeronautical Equipment Division. A 20-year Sperry veteran, he has made important contributions in all phases of instrument and control engineering. He pilots both fixed-wing aircraft and helicopters.

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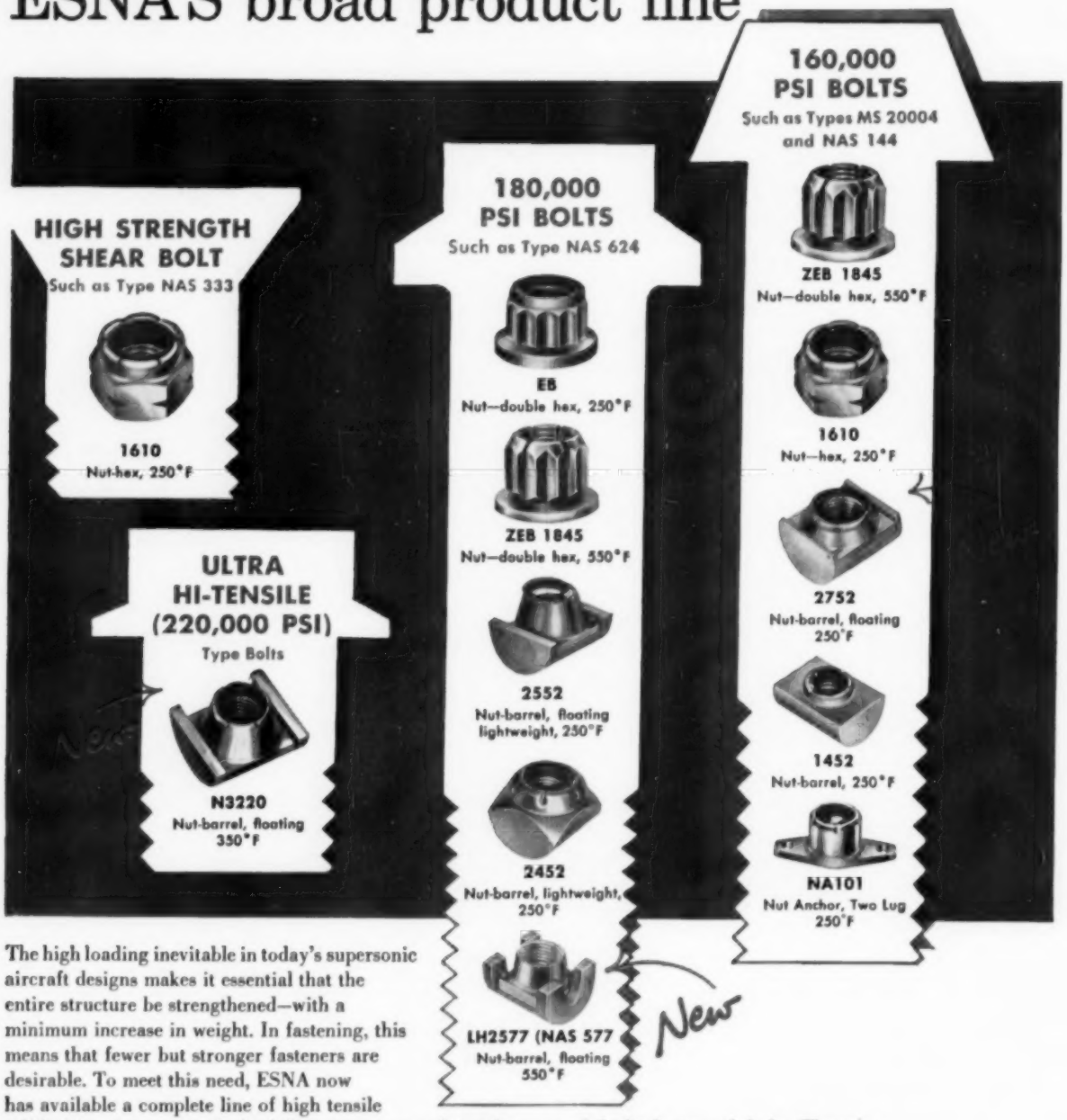

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We will be glad to send you complete details on any of the nuts shown here or to help you with any of your specific fastener problems. Just write Dept. N45-1225.

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